BULLETIN

OF THE

Society for the Promotion of Engineering Education

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EDITORIAL.

The Virginia Meeting.—The first meeting of the Society south of the Mason and Dixon Line will be held June 19–22, at the University of Virginia. As has been noted in the plans already announced in the BULLETIN, it is evident that this is

going to be one of the most enjoyable meetings this Society has ever held. This meeting also marks another epoch in the history of the Society in that the papers will be limited; the reports of the committees will be extensive, and the discussion of the committee reports will form a large part of the meeting. This will give every member an opportunity to take part and contribute to the subject of engineering education. The reports of the committees will be based on the answers to the extensive questionnaires which have been sent out during the year and should prove profitable and enjoyable to everyone.

THE MONTHLY LETTER.

An effort is being made to have all of the reports of the committees ready for printing in the June BULLETIN. So many members object to having their papers printed far in advance of the meetings, while admitting the desirability of having copies of the papers available as a basis for discussion, that the Publication Committee has adopted this plan as being the best compromise possible.

Some changes in the constitution that have become desirable because of developments in the work of the Society have been made and approved by the Council, and will be printed in the June BULLETIN as a prelude to their presentation to the Virginia meeting for action.

Comments both favorable and otherwise are being received on the change in the title of the BULLETIN as it appeared on the front cover of the April number. The former title, containing as it did ten words, was thought by a good many members to be too bulky for convenient use. An effort has been made during the past year or two to emphasize the words "Engineering Education" in all of the printed matter of the Society with the aim of ultimately changing the name of the BULLETIN to the shorter title. The change was made in the April number in order to provoke comment. The Committee would be glad to have your opinion.

President Jacoby spent Monday, April 10, in Pittsburgh going over the work of the Society with the Secretary.

COUNCIL ACTIONS.

The Council of the Society has, by a letter ballot, elected twenty-six individual members. The names of these new members will be found below.

NEW MEMBERS.

BERRY, H. C., Professor of Materials of Construction, University of Pennsylvania, Philadelphia, Pa.

BROUEN, J. M., Professor of Civil Engineering, University of South Dakota, Vermilion, S. D.

BUTLER, G. M., Dean Colleges of Mines and Engineering, University of Arizona, Tucson, Ariz.

COBB, COLLIER, Professor and Head of Dept. of Geology and Mineralogy, University of North Carolina, Chapel Hill, N. C.

DAVIDSON, M. W., Professor of Mechanical Engineering, University of South Dakota, Vermilion, S. D.

ELLIS, C. A., Professor of Structural Engineering, University of Illinois, Urbana, Ill.

FORMAN, A. H., Assistant Professor of Experimental and Electrical Engineering, West Virginia University, Morgantown, W. Va.

GOULD, F. A., Professor of Civil Engineering, James Millikin University, Decatur, Ill.

GRAHAM, P. H., Vanderbilt Fellow in Astronomy, University of Virginia, University, Va.

GRUNDHOEFFER, E. F., Instructor in Mechanical Engineering, University of Colorado, Boulder, Colo.

HALE, R. S., Supt., Special Research Dept. Edison Illuminating Company of Boston, Boston, Mass.

HAMMOND, H. P., Assistant Professor of Civil Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

LEWIS, F. J., Assistant Instructor in Civil Engineering, The Pennsylvania State College, State College, Pa.

MANN, C. V., Instructor in Engineering Mathematics, University of Colorado, Boulder, Colo.

MURRIE, J. L., Supervisor, Cadet Engineer Corps, The New York Edison Co., New York, N. Y.

MCEACHNON, K. B., Professor of Electrical Engineering, Ohio Northern University, Ada, O.

PARKER, J. C., Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich.

RAY, H. C., Professor of Ore Dressing and Associate Professor of Metallurgy, University of Pittsburgh, Pittsburgh, Pa.

REID, E. A., Instructor in Electrical Engineering, University of Minnesota, Minneapolis, Minn.

SLAGLE, W. C. H., Assistant Professor, University of Pennsylvania, Philadelphia, Pa.

SNAVELY, T. R., Fellow of the Phelps-Stokes Foundation, University of Virginia, University, Va.

STAPLES, E. I., Instructor in Electrical Engineering, University of North Carolina, Chapel Hill, N. C.

ST. JOHN, E. R., Designing Engineer, American Bridge Company, Pittsburgh, Pa.

THORNTON, W. M., Professor of Applied Mathematics and Dean of Dept. of Engineering, University of Virginia, University, Va.

WATERMAN, I. F., Instructor in Civil Engineering, John B. Stetson University, DeLand, Fla.

WRIGHT, C. A., Associate Professor of Electrical Engineering, Iowa State College, Ames, Ia.

APPLICANTS FOR MEMBERSHIP.

CARMICHAEL, F. L., Assistant Professor of Mathematics, University of Alabama, University, Ala. Gustav Wittig, G. J. Davis, Jr.

FOLWELL, A. P., Managing Editor, Municipal Journal, Montclair, N. J. F. L. Bishop, L. C. McCandliss.

LITTLE, G. T., Power Plant Operation, Stone & Webster Management Association, Pawtucket, R. I. W. H. Timbie, A. B. Newhall.

WOLFE, W. S., Instructor in Architectural Engineering, University of Illinois, Urbana, Ill. G. P. Boomsliter, M. L. Enger.

BOOK REVIEWS.

The Railroad Taper. By LEE PERKINS, formerly Assistant Engineer, Southern Pacific Lines in Arizona and Mexico. John Wiley & Sons, Inc. 1915. $4 \times 6\frac{3}{4}$, Leather. 365 pages, 41 figures, 42 tables. $2.50 net.

In this book complete instructions with examples and tables, are given for staking out a transition curve of rather unusual form. Instead of using some form of parabola the author uses a compound transition curve made up of regi-

ments of a circular arc with 30 feet of chord lengths. The mathematics involved in the usual transition curve is very much simplified by the use of the circular arcs and the author claims the curve is elastic enough to fit all conditions.

L. C. M.

Solid Geometry.

Solid Geometry. By WILLIAM BETZ, Vice Principal and Head, Dept. of Mathematics, East High School, Rochester, N. Y., and H. E. Webb, Head, Dept. of Mathematics, Central Commercial and M. T. H. S., Newark, N. J. Ginn & Co. 1916. $7\frac{1}{2} \times 5$. xxii + 177 pages.

The arrangement of the material is such as to throw special emphasis upon the essentials of the subject and the treating together of such topics as prisms and cylinders and of pyramids and cones tends to reduce to a minimum the number of theorems necessary. The abundance of illustrations and suggestions of models to be constructed will greatly assist the student in his conception of the relative positions and proportions of the various solids studied.

The collection of the theorems and facts of plane geometry in the first few pages of the book enables one to use it as a text without requiring the class to purchase the plane geometry also. The historical notes always appeal to me as decidedly worth while.

The presentation throughout is clear, concise and straightforward and it impresses me as a thoroughly teachable text.

F. J. H.

COLLEGE NOTES.

Lafayette College.—Preparations for the inauguration of a coöperative course in Mechanical Engineering at Lafayette College have been completed. Professor E. O. Fitch, Jr., of the Department of Mechanical Engineering has issued a special bulletin setting forth the scheme under which this course will be operated. The first actual work will be done in June when the members of the sophomore class will go into the shops of the industrial plants of the Lehigh Valley to work

during the summer. At the beginning of the college year next September, the students in the junior and senior classes who elect the coöperative plan will be sent two weeks to some one of the coöperating shops and then will take two weeks in the classroom. This alternating scheme of practical and theoretical work will last for three years and it will thus take a student five years to complete the coöperative course. The plan throughout is essentially the same as that which has for a number of years been so successful at the University of Cincinnati.

The success of a course of this sort rests very largely on the location of the institution offering the course. As a frontispiece to Professor Fitch's bulletin there is a map at the center of which is the city of Easton where Lafayette College is located. Within a radius of fifteen miles are some of the most important industries and railroads of the east such as the Ingersoll-Rand Co., the Bethlehem Steel Co,. the Taylor-Wharton Iron and Steel Co., the Warren Foundry Machine Co., the American Horseshoe Co., the Alpha Portland Cement Co., and five other important cement companies; the Pennsylvania, Lehigh Valley, Jersey Central, D. L. & W., Lehigh & Hudson, Lehigh & New England railroads, a number of large silk mills and a heterogeneous group of important industries. Practically all of these concerns will coöperate with the college in the new course.

An educational scheme of this sort cannot be properly governed by purely educational men as are found in a college faculty. In order, therefore, to keep the government of the new course in line with business as well as educational advance, an advisory board has been elected by the trustees of the College which is composed partly of business men and partly of college representatives. The personnel of this board is as follows: George R. Elder, Vice-President and General Manager Ingersoll-Rand Co., Chairman; Knox Taylor, President Taylor-Wharton Iron and Steel Co.; Ralph H. Sweetser, President Thomas Iron Co.; Israel P. Pardee, President Board

of Trustees, Lafayette College; James Gayley, Member Board of Trustees, Lafayette College; A. C. Overholt, Member Board of Trustees, Lafayette College; John H. MacCracken, President Lafayette College; E. O. Fitch, Jr., Professor of Mechanical Engineering, Lafayette College, Secretary.

Stevens Institute of Technology.—Stevens Institute of Technology recently bought a block of ground comprising about two acres, lying directly east of the main building. This purchase, together with the purchase of seven acres last fall from the private grounds of the Stevens estate, gives to the Institute all of the land north of Fifth Street to the Castle and permits of future building to the best advantage. It marks the consummation of plans laid down by President Alexander C. Humphreys some years ago for the acquisition of such available land in the immediate vicinity of the college as might be necessary for future development. The college now possesses a total of about twenty-three acres lying on rising ground in the city of Hoboken, N. J., with the Stevens Castle at the crest. It has a frontage of 1,600 feet on the bluff overlooking the Hudson River, New York City and the Narrows. Ample room is provided for future growth amid secluded surroundings famed in engineering annals as the scene of the developments of John, Robert L. and Edwin A. Stevens in steamboating, railroading and armorclad naval construction.

REPORT ON CIVIL ENGINEERING.

Editor's Note.—The following report contains the tabulated results of the questionnaire sent out by the Committee on Improvement in Laboratory Practice (Civil Engineering, appointed at the Princeton meeting). The data were secured in the winter and spring of 1915. The work of tabulation, etc., was done by Professors W. E. Mott and C. B. Stanton, of the Carnegie Institute of Technology.

Later this committee was combined with others to form Committee No. 15, Civil Engineering, with the same chair-

man but with additional members. This report, therefore, is the work of the old Committee on Improvement in Laboratory Practice and will be discussed at the Virginia meeting.

QUESTIONNAIRE.

Required

Course:—(Title) .....Catalogue No .....Optional
Taken by students in ..... Eng. course.....semester of the..... year. Given during college year or summer vacation?
Number of credits given for completion of course .....
Total actual hours required for entire course. Recitation .....
Laboratory ....., Drawing room ....., Field .....
Text book used: (Please indicate under this heading what general topics are covered in the course and the approximate time apportioned to each, giving recitation, laboratory, drawing room and field work separately.)
Do you consider that more, or less, time should be given to this course than indicated above .....? Please give reasons.

SUMMER SCHOOL.

SURVEYING, GEODETIC AND RAILROAD FIELD WORK.

Where is this work carried on?
Total actual hours required:— ..... Are these hours included under "Field" on the opposite page?
Are the students quartered in hotel?
Does the college own a permanent camp site? .....
Does the college operate the mess? .....If not, how are meals provided?

Is a camp "store" maintained? .....Is one desirable? .....
Are courses other than those indicated above given during Summer School?
What total sum is charged each student for board per week? .....
What total sum is charged each student for lodging per week? .....
What total sum is charged each student for instruction per week?.....
What is the transportation expense, per student, to and from the college? .....
What other regular charges are made? .....
What equipment must the student provide?
What equipment does the college provide?
Name of College answering
.....
.....
(Signed).....

SHEET 1 of 2

SURVEYING AND GEODESY

	Institution	Title of Course	Course No.	Credit Hours Course	Credit Hours Term	Term	Type	Time Class	Time Lab	Time Home	Time Other	Time Total	Text Book	Remarks	
1	Arizona, Univ of	Civil Engr.	142	3	4	Sp	Elem	6	6a	3h	0	12a	————	Elementary Topographic and Mine Surveying	1
	"	"	144	2	4	Sp	Elem	4	3z	3h	0	10a	————	Elementary Surveying. Optional for Abs.	
	"	"	3	CE	0	Su	Camp	1	1h	0	0	1a	————	Geodesy	
2	California, Univ of	Surveying	102	CE	4	Fa	Elem	6	6a	3h	3h	12a	Stadia, Plane Table, Hydrographic	Stadia, Plane Table, Hydrographic Abs. get ½ time = 3 Credits	2
	"	Geod. Surv.	122	CE	4	Fa	Adv	2	2	3h	0	5a	Ivanov	Power of Least Squares, Field Methods, Reduction of Observations	
3	Carnegie Inst. of Tech	Surveying	121	CE, EE, M	4	Sp	Elem	3	3h	3h	0	6h	B.& H.	C.L.T. AM.S. Maps and Computations. U.S. Land Surv. All Surveying at Camp	3
	"	"	123	CE, EE, M, Ch	4	Sp	Adv	0	0	0	0	0	P.& K.	L.T. Computations and Maps	
	"	"	124	CE & CH	4	Su	Camp	1	3	24	—	44	Tracy	C.L.T.AMS. Maps and Computations. Night Students (3 years to obtain certificate)	
	"	Geodesy	158	CE	4	Fa	Lec	2	2	3h	0	4a	B.& H.? Hosmer's Azi	Δ. Base Line, Precise Levelling, Sm. Latitude, Time, Azimuth	
4	Colgate, A & M College	Civil Engr.	4	CE, EE, ME	A	Sa	Elem	3	—	3h	0	6h	B.& H.?	No Coast System. C.L.T.	4
	"	"	6	CE	A	Wi	1	—	—	3h	0	3h	B.& H.?	" " P. Top. A	
	"	"	4	CE	A	Su	1	—	—	3h	0	3h	B.& H.?	P. Surv. Practice, Railroads and Misc.	
5	Colorado, Univ of	Plane Surv.	102	CE	A	Su	1	4	12	4h	0	20a	P.& K.	ACLP.Sa. U.S. Land Topographic Mapping	5
	"	Top.	78	CE	A	Su	2	4	16	4h	0	24a	P.& K. Adams's Top. Surv.	Topography, Surveying. Δ. Calculation	
	"	Elect.	96	ME, Elect.	A	Su	2	2	12	3h	0	17a	P.& K.	Should be 3 credit hours. Short Course	
6	Columbia, Univ	Civil Engr.	23	ALL	A	—	—	3	45	0	0	45	R.	C.L.T.A.P.S. U.S. Land, Top. Given either at college or Summer school	6
	"	"	153	CE, Civil Engr.	A		Camp	3	0	0	0	240	—	L.T.S.M.	
	"	"	203	CE	A		"	3	0	0	0	240	—	P. Top. surv. City surv. Δ. M. (Advanced work on course 153)	
	"	"	263	CE, SE	A		"	2	0	0	0	96	—	Δ. Hydrographic Surveying, Current meters, Floods, Etc. (Given in Term, Nineteen Long)	
	"	Astronomy	103	CE	A		"	3	0	0	0	144	—	Δ. Base Line, Adjustment Quadrilateral, Least Squares, Time & Lat. by Sx., Star & Trig. Lin., Lat. Long.	
	"	Civil Engr.	203	Civil Engr.	A		"	3	0	0	0	240	—	Same as 253. City surv. converted. Mine surv. added	
7	Denver, Univ of	Plane Surv.	—	CE	O	5th	—	—	—	—	—	—	Tracy	(Night) school. Students given Saturday AM during summer	7
	"	"	—	CE	A	3rd	Elem	0	30	15h	45	2a	Tracy	A few lectures on Geodesy.	
8	Delaware, College	Civil Engr.	15	CE	A	So	Elem	3	72	3h	0	10a	Barnard & R.	————	8
9	Drexel, Univ of	Surveying	104	Civil Engr.	O	—	Elem	4	—	—	—	8h	B.& H.?	————	10
10	Florida, Univ of	Surveying	1	CE	A	Su	1	3	3z	2h	1h	6a	J.& S.	C.L.T. U.S. Land. Plotting of maps	11
	"	"	34	CE	A	Su	2	11	16	2h	4h	10a	J.& S., P.& K.	S.P.S.a. Top., Hyd., Top. Mapping	12
11	Franklin, Union	Eng. & Sum. Calc.	1	CE	A	Fa	1	—	4h	—	—	4h	Tracy & Horres	————	13
	"	Land Subdivision & Law	2	CE	A	Fa	2	—	4h	—	—	4h	Tracy & Horres	————	
12	George Washington, Univ	Surveying	1	CE	A	Su	Elem	3	6h	3h	3h	12h	B.& H. 102	————	13
	"	Astronomy	8	CE	A	Wi	2	1	3h	0	0	3h	Hosmer's Azi	Azimuth & Time	
13	Georgia, School of Tech	Plane Surv.	102	CE	A	Fa	2	5h	6h	0	0	11a	C.L.T.A.	C.L.T.A. Comps & Draughting	14
	"	"	104	CE, Civil Engr.	A	Su	1 or 2	5h	6h	4h	0	—	Tracy	C.L.T.S. Top., Areas, Comps.	
	"	City Surv.	106	CE	A	Su	1	8h	6h	3h	0	—	B.& H.	S.P.M. U.S. Land. City surv.	
14	Georgia, Univ of	Elem. Surv.	1	Ag. Engr.	A	Su	Elem	3	102	0	0	102	Hosmer's Azi. Surv.	————	15
15	Harvard, Univ	Plane & Top. Surv.	1	Ag. Course	O		Camp	—	210	70	0	140	B.& H.?	C.L.T.S.P. Base Line, M. Su. (30 hours of tests)	16
16	Iowa, Univ of	Surveying	1	CE, Civil Engr.	O	Su	Elem	6	64	18z	—	18a	J.& S., P.& K.	E.E. take only one term. C.L.T. ANS.N. City, Mining, Top.	17
17	Iowa State College	Civil Engr.	102	CE, Civil Engr.	A	Fa	1	2	0	0	18z	0	P.& K.	4&5 Year C.E. Courses and 4 Year E.M. Course C.L.T. (Field)	18
	"	"	203	CE	A	Fa	2	2	3h	0	0	5h	J.& S.	4&5 Year C.E. Courses C.L.T. (Theory)	
	"	"	210	CE	A	Fa	2	2	1?	0	0	5?	P.& K.	2 Year Structural Draughtsmen & Bldg. Supts. Course. L.T.& Timework	
	"	"	211	CE	A	So	1	2	1?	0	0	5?	P.& K.	2 Year Surveyors & Roadmasters Course. C.L.T. Comps of Areas	
	"	"	212	CE	A	So	1	2	1?	0	0	5?	P.& K.	" " A. and Road Problems	
	"	"	318	CE, EE, M	A	So	1	2	3h	0	0	5h	J.& S.	4&5 Year C.E. Course and 5 Year E.M. M. Top. Mining. Top.	
	"	"	231	CE	A	So	1	2	1	0	0	3a	P.& K.	4&5 Year C.E. Course. L.T.A.P. Field Methods. U.S. Land. Earthwork Comp.	
	"	"	418	CE	A	So	2	2	0	0	10z	0	P.& K.	4&5 Year C.E. Course. L.T.A.P. Field Methods. U.S. Land. Earthwork	
	"	"	419	CE	A	So	2	2	3h	3h	0	8h	J.& S.	4 Year C.E. take 419; 5 Year take both. Geod. Lat. Long. Azm. & Time	
	"	"	304	Ag.	A	So	1	3	1?	0	10z	0	P.& K.	4&5 Year Ag. Course. L.T.A. Computations. U.S. Land & Surveys	
	"	"	416	Ag. E.M.	A	So	2	3	1?	0	10z	0	P.& K.	5 Year E.M. & Ag. " ——— do ———	
	"	"	451	EE, M.E.	O	Ja	2	3	1?	0	10z	0	P.& K.	5 Year E.E. & M.E. Courses L.T.S.A. U.S. Land Computations.	
	"	"	203	E.M.	A	Fa	2	3	1?	0	10z	0	P.& K.	4 Year E.M. Course ——— do ———	
	"	"	401	Forestry	A	So	2	2	0	0	10z	0	P.& K.	4 Year Forest Course. Use Forest Compass (Preparatory to Forester's Camp)	
	"	"	402	"	O	So	2	2	0	0	10z	0	P.& K.	5 Year Forestry Course. L.T.S.A. U.S. Land. Computations	
	"	"	537	"	A	Ja	1	3	3h	0	10z	0	P.& K.	5 Year " " C.L.T.P. U.S. Land. M. Top. Comp.	
	"	"	438	"	A	Ja	2	3	3h	0	10z	0	P.& K.	5 Year " " ——— do ———	
18	Johns Hopkins, Univ.	Surveying	—	CE, EE, ME	A	Su	Elem	—	0	40	0	100	Tracy	Plane surveying only	19
19	Kansas State Ag. Col.	Surveying	1	CE	A	Su	1	1	3z	7h	0	10z	J.& S.	A. Land. Top. H	20
	"	"	11	CE	A	Ja	1	1	3z	3h	4h	0	J.& S.	City. Mining. Comp. Curves, Top.	
	"	Geodesy	—	CE	A	Sa	2	4	2z	1z	3z	0	J.& S.	Δ. Base Line, Precise Levels & Map Projection	
	"	Surveying	—	CE, ME	A	Su	2	3	11	44	0	12a	P.& K.	L.T. Use of Instruments. B.A.	
20	Kansas, Univ of	Plane Surv.	5	CE	A	—	—	5	6h	5h	5h	24a	B.& H.? 102	C.L.T.A.M.S. Mining, City	21
	"	"	105	CE, Civil Engr.	A	—	—	3	3h	3h	4h	10a	B.& H.?	C.L.T.A.S.	
	"	"	106	CE	A	—	—	2	0	10z	0	0	————	Topographic & Geodetic Mapping	
	"	Geodesy	108	CE	A	Sa	2	3	3h	0	0	3h	————	Field and mapping work included under CE 2 and CE 5	
21	Lehigh, Univ	Land Surv.	22	CE	A	So	2	4	1?	4h	4h	17h	Tracy	————	22
	"	Geodesy	167	CE	A	So	1	3	3h	0	4h	10a	Hosmer's Azi. Surv.	————	
22	Maine, Univ of	Plane Surv.	102	CE, Summer	A	So	1	24	2?	0	9h	35a	J.& S., P.& K.	C.L.T. & U.S. Land	23
	"	Plotting	202	CE	A	So	2	1h	0	7z	0	0	P.& K.	Plotting and Computation	
	"	Field Work	204	"	A	So	2	4	0	0	36	0	P.& K.	Field work of C.E-1	
	"	Adv. Surv.	302	"	A	So	2	2	3h	0	0	5h	J.& S. & References	Δ. P.S. Base Line, Precise Levels	
	"	Adv. Surv. Methods	303	CE, ME	A	—	1	2z	3h	0	0	3h	B.& H.?	Short Course [surveying were given]	
23	Maryland, Agriculture Col.	Surveying	121	CE	A	Fa	—	14	8h	13z	—	0	C.L.T.S.A. City	C.L.T.S.A. City *Better results could be obtained in shorter time if summer	24
	"	"	122	CE	A	Fa	2	2	0	4h	—	0	P.& K.	Corr. Use and Adj. of instruments and elementary operations	
	"	"	123	CE	A	Fa	2	4	22z	4h	—	0	B.& H.*2	Azm., Lat., Time Δ.	
	"	Geodesy	180	CE	A	Sa	2	4	22z	4h	3z	0	B.& H.*2	C.L.T.A. Top., Drainage, Computations, Areas	
24	Mass. Inst. of Tech	Surveying	1	CE, SE	A	Ja	Elem	—	100	—	3hs	0	B.& H.	Plane, Top. and Hyd.	25
	"	Geodesy	103	CE	A	Ja	2	—	25	5h	5h	0	Bart's Osmosis Elem.	Δ. Base Line, Long., Azm., Map Proj., Calculations, Theory of Spheroid	
25	Missouri College of Mines	Surveying	101	CH	A	Fa	2	—	12	100	35h	—	————	Summer term	26
26	Missouri, Univ of	Surveying	1	CE	A	Ja	1	3	2h	0	2h	0	Tracy, Adams C.& E.	C.L.T. and Surveys	27
	"	"	2	CE	A	Ja	2	4	32	64	64	0	——do——	S.P. Top. Cross Sect. H. Δ. Maps	
	"	"	4	Architecture	A	—	Elem	2	1h	0	6h	0	Tracy	L.T. (Given also in summer vacation)	
	"	"	104	Mechanical	A	—	Elem	8	1h	0	19z	0	Tracy	L.T. ——do——	
27	Missouri, Univ of	Surveying	1	CE	A	—	Elem	1	5	2h	3h	0	Tracy	R.	28
	"	"	6	CE	A	—	Elem	3	2h	6h	10h	0	Tracy	C and Chain class	
	"	"												L.T. & Top.	
28	Mizzou, Univ of	Elem. Surv.	100	CE, ME	A	—	1	2	1h	0	4z	0	ME or P&K or B&H	Course to be dropped and course 103a to be substituted	29
	"	"	103	CE	A	—	1	2	3h	0	6h	0	J.& S.	Arts 1 to 16, 144 to 208. C.L.T. Azm., Time, Comps., Maps.	Elem. Added Azim., S.P. Maps
	"	"	104	CE	A	—	1	3	2h	0	6h	0	J.& S.	Arts 26 to 144, 221 to 242, 258 to 288 & 432. Increase to four hour course next year; Plane Surveying & Precise	
	"	Higher Surv.	105	CE	A	—	2	3	2h	0	6h	0	J.& S. Oak Hammock Surv.	Chaps 14 (Except 482 to 462) and Chap 17, 18 (also in Hammock Chap (1939) (Except Arts 32-39) Chaps 4, 7	
	"	Geodetic	106	CE	A	—	2	3	2h	3h	4h	0	J.& S.	—— (Except Arts 57-59) Chap 11, Base Line, Δ. Precise Level, Azim., Sph. & Proj. Art. prereq.)	
29	Montana State School of Mines	Plane Surv.	—	CH	A	Fa	2	3	3h	8h	0	22h	Tracy	Surveys of Mines and Computations	30
	"	Mine Surv.	—	CH	A	Sp	2	3	3h	8h	0	22h	Lee's Mines	L.T. Bldg. Foundations, plans, cross-sections, excavations	
30	Nebraska, Univ of	Elem. Surv.	221	ME	A	Fa	2	2	1?	0	5?	10a	P.& K.	C.L.T. Comps.	31
	"	Surveying	222	CE, E.E., M.E.	A	Sp	2	4	3h	3h	7?	0	B.& H. 102	Part 2, 101 2. Stadia & Mining	32
31	Nevada, Univ of	Surveying	102	CE, E.E., M.E.	A	Sa	Elem	3	6h	3h	6h	15a	B.& H. 1	Abs take one term. C.L.T. A.S.P.M.N. Mining, City, Top. Maps.	33
	"	Cartography	104	CE	A	Sa	2	1	0	4h	0	5a	K.C.S. Practicum	Plotting compilations, and conventional signs	
	"	Plane Surv.	1	CE	A	Ja	2	4	3h	3h	6h	13a	————	Land and Top. surv. and computations	

No.	1 INSTITUTION	2 TITLE OF COURSE	3 Cat. No.	4 Semester Credits	5 Req.	6 Elec.	7 Year	8 No. of Times Offered in Last Five Years	9 Hours Allowed for Work Lec.	10 Lab.	11 Total	12 Hours Credit Allowed	13 TEXT BOOK	14 REMARKS
39	New York Univ	Elem Surv	Su1	CE	R	So	1	4	45	15	30	0	1925	J&S	C.L.T. Level Surv
	"	Surveying A	Su2	CE	R	So	2	4	45	15	30	0	1925	J&S	"Use of course "Top, Hyd, City and Mine Surveying" Shows Cropsey, Earthwork
	"	Geodesy	Su3	CE	R	Jn	1	1	15	15	15	0	1925	Comstock's Geodesy	
114	No Dakota Univ of	Surveying	1	No Exams	R	Fr	1	1	18		50	0	1925	None	L.T. Elementary problems
	"	"	4	CE	R	Sn	2	4	32		128	—	1925	Lee's Surv Manual, B&H	C.L.T.P. Current Meter, P.R. Curves, Areas
	"	Advan & Geod	5	CE	R	Jn	1	2	72		288	—	1925	Hosmer's Adv & Refer	T.S., Altazimuth, Ry Inst, Time & Lat. Obs.
115	Northwestern Univ	Engineering	20a	No Exams	R	So	Term	6	54	0	81	288	1925	J&S	C.L.T.A.M.P.S.A. Computations, hypsographic Hydrog. Base line
116	Norwich Univ	Surveyor Course	—	—	—	—	—	—	—	—	—	—	—	—	All work given at summer school (See summer school sheet)
117	Ohio Northern Univ	Plane Surv	1a	No Exams	R	1st	Sem	5	54	54	48	0	1926	P&H	
	"	Field Eng	1b	CE	R	2nd	Semes	5	54	54	48	0	1926	J&S	
	"	Geodesy	2a	CE	O	3rd	Semes	2.5	24	24	24	0	1926	Merriman's Precise Surv	
118	Ohio Univ	Surv & Drafting	1.15	CE, EE	R	Fr	2	6	36	0	36	0	1925	"	C.L.T.S. Maps, U.S. Land Do some summer school work
	"	Top Surv	1.16	"	R	So	1	3	24	18	18	0	1925	Wilson and several others	Base line, S.A. Balancing, Alig, Azimuth.
119	Oklahoma A.&M. College	Elem of Surv	2a	All Exams	R	Sn	1	½	0	0	36	0	1925	Notes	Care, use and adj. of instr. and elementary operations
	"	Surveying	2.03	CE	R	So	2	3	36	0	72	0	1925	B&H	Top surv, 24 class, 48 field. Geodetic, Astron, 24 field
	"	Top Drawing	3.07	CE	R	Jn	1	½	0	36	0	0	—	None	Plotting notes from surveying course
120	Oregon Agricultural College	Plane Surv	1.1	CE	R	Fr	2	5	52		144	0	1926	B&H?	
	"	Top Surv	1.2	CE	R	So	1	5	36	54	108	0	—	B&H, 742	All of B&H 742 except Geodetic
	"	City Surv	1.3	CE	O	Sn	1	3	18	54	54	0	—	B&H, J&S	Surveys etc with reference to city work
	"	Precise Surv & Geod	1.4	CE	R	Sn	2	3	36	0	54	0	—	Text as selected	Precise leveling & Lat. Azimuth, Meridian
	"	Top Surv	1.5	CE	R	Jn	1	2	12	36	48	0	1925	"	Complete top. survey and map computations
	"	Hydr Surv & Irrig	1.6	Agric	R	Sn	1	2	18		54	0	1926	"	L.T. Drainage, Irrigation & Highway surveys
	"	Top Surv	1.5	CE	R	So	1	4	18	36	90	—	—	B&H	Top map of forest section
	"	Plane Surv	1.1	CE	R	Fr	2	4	54	0	162	0	1926	B&H?	"Same as "2.02"
121	Pennsylvania College	Surveying A	1.13	CE, Met E.	R	Jn	1	2	36		0	145	1925	Tracy	All the book except chaps on S.P. Top. M. Parking land earthwork, Ford's Appendix
	"	" B	1.14	CE, Met E.	R	So	1	2	36		0	145	1925	Tracy, B&H 2	Take all that is omitted in 1.13 Selections from B&H 2
	"	" C	1.15	ME, EE	R	So	1	1	—	48	—	0	—	Tracy or Lee's Manual	Short course may be elected by liberal arts students
122	Pittsburgh Univ of	Elem Surv	2.01	CE	R	Fr	Spring Semester	3	22	0	33	0	1925	Tracy	C.L.T.
	"	Top "	2.03	CE, SE	R	So	1st Sem	4	11	33	66	0	1926	Tracy	P.S. Top surveying
	"	Geodesy	5.01	CE -	R	Sn	Fall	4	36	0	36	0	1926	Comstock Geod & Notes	Precise methods
123	Poly Inst of Brooklyn	Elem Surv	1.0.1	CE	R	So	Term	—	63	126	126	0	1925	Tracy	L.T.
	"	Plane Surv	1.0.2	CE	R	So	Term	—	54	216	162	0	1926	B&H 2	
124	Purdue Univ	Comp. Eng.	3	CE	R	So	—	—	54	0	108	0	1926	J&S, Hayb	Given during summer session, A.D. Hyd, Base line, M.R.R. Surv
125	Rochester Mechanics Inst	Surveying	13.1	CE	R	Fr	1	—	120	36	0	0	Term	B&H?	Whole volume
	"	"	13.2	CE	R	Fr	Summer	0	0	0	0	90	—	—	(Summer C.E.'s Camp surveys)
	"	"	13.3	ME	R	Jn	"	0	0	0	0	72	—	—	
126	Rose Poly Inst	Elem Surv	—	CE	R	Fr	2	3	27	54	108	0	1925	R	One added credit may be elected More hrs desired if 2 could be put in the
	"	Top Surv	—	CE	R	So	1	3	0	54	108	0	1925	R	T.S.P.A. Map
127	Rutgers College	Surveying	3.01	CE	R	So	2	—	50	0	200	100	1925	Burbee, Plane Surv	C.L.T.A.S.
	"	Plane Surv	3.02	CE	R	So	2	—	33	0	0	100	1925	Burbee, Plane Surv	May cut to 3 hours recitation. A.M. Precise leveling, P. Map projection
	"	Method & Geod	3.03	CE	R	So	2	—	72	36	36	0	1926	B.& H.	C.L.T. Map and computations
128	Sheffield Scientific School	Plane Surv	1.1	CE	R	Jn	1	—	54	0	60	130	1925	Tracy, Surv & Field Manl	C.L.T.A.S.P. Top., simple curves
129	So California Univ of	Elem Surv	1a	All Exams	R	Fr	Term	8	64	32	160	0	1926	B&H 2, P&H	Top. Mapping
	"	"	1.1	CE	R	So	1	4	32	32	64	0	1926	B&H 2	(per week 1st Term Jan.
130	So Dakota State Sch of Mines	Surveying	1.1	CE	R	So	Term	—	60	0	120	180	—	J&S	All the book except chaps 10 and 11, includes lectures on R.R. surveys (Top Draw 3hrs
	"	Plane & Mining Surv	1.2	ME, Met	R	So	"	—	36	0	36	144	1926	J&S, Durham Mine Surv	Field & chaps & R.R. 20.3. Eight weeks Durham. 1 week mine survey
	"	Plane Surv	1.1	CE	R	So	1st	—	72	0	36	216	1925	J&S	Field & chaps. 20.3
131	State Univ of Iowa	Surveying	1a	All Exams	R	Fr	Term	2½	0	0	0	135	0	1925	U.S. Land, use of instr. etc. To be given in summer school next year
	"	Surveying	4	CE	R	So	2	3	0	0	0	162	0	1925	Top, Hyd, Mining, Mekanics, Maps
	"	Field Astron	6	CE	R	Jn	1	—	27	—	—	0	1925	—	Astron, Lat, Long, Time. Methods adapted to field instruments
132	Stevens Inst of Tech	Surveying	—	ME	R	Fr	Term	—	0	32	56	0	1926	Notes	L.T.S.
133	Swarthmore College	Surveying	22.3	CE, EE, ME	R	So	2	2	18	9	36	0	1926	B&H	C.L.T.A. Methods computations, plotting
	"	Surveying	22.4	"	R	Jn	2	2	0	18	36	0	1926	B&H?	Top. Mapping, S, Buildings, sewers, pavements, precise chaining
134	Temple Univ	—	—	CE	R	So	Term	3	51	102	102	0	1925	J&S	—
135	Texas State Sch of Mines	Surveying	2.1.0	EM	R	Fr	2	3	30	0	0	210	1925	Tracy	U.S. Land, mineral surv Use of instr.
136	Trinity College	Civil Eng. & Surv	1a	Science	O	—	1	—	17	68	—	0	1925	—	Use of instr.
137	Tulane Univ	Plane Surv	3.2.1	CE	R	So	1	2	6	0	44	0	1925	B&H 702, J&S, P&H	C.L.T.
	"	Higher Surv & Astr	3.2.2	CE	R	So	2	3	8	12	56	0	1925	— do —	S.P.M.A. Base line
	"	Top Drawing	3.2.3	CE, EE	R	Jn	1	3	4	12	0	—	—	B&H, J&S	Plotting maps and computations
	"	Elem. Surv	3.1.1	CE, ME, Met E	R	So	1	2	6	0	44	0	1925	P&H	Short course
138	Union Univ of Sch of Mines	Surveying	3.01	Sch. Civ. Chem	R	So	Term	4	36	36	48	0	1926	J&S, P&H	C.L.T.P. Underground surv.
	"	Mineral Surv	3.02	CE, EM	R	Jn	Summer	6	0	100	200	0	1926	—	Underground R.R., claims 120
139	Valparaiso Univ	Plane Surv	1	CE, Arch	—	Fr	1	1	60	0	120	—	1925	R	C.L.T.A. Su, Comp. and U.S. Land
	"	"	1a	CE	—	Fr	1	1	12	0	48	0	1925	R	Theo. Top, P.S., Spanish, maps etc.
140	Vanderbilt Univ	Surveying	1	CE, EE, ME	R	So	1	4	32	30	64	0	1926	Thomas & Raines Fields M.	Many time needed for ME
	"	"	1.1	CE	R	So	2	4	32	30	64	0	1926	— do —	Opt. for ME, EE & Chem. P.S.A. Astron, Top, Hyd, L.T.S.P.A.
	"	Geodetic Surv	3	All	O	Sn	1	3	48	—	—	—	1925	Davis's Elem. of Geod.	Not elected for past five years
141	Washington Univ of	Plane Surv	2.0	ALL	R	Fr	2	4	32	36	60	0	1926	Tracy	L.T.A. computations
	"	Top Surv	2.3	CE	R	Jn	1	3	16	0	32	0	1926	J&S	Δ Base line P.S. Photographic surv, Map (should be given I
142	Wash & Lee Univ	Surveying	2	All Exams	R	Fr	1.2.3	4	100	35	35	0	1925	Gillespie & B&H	2 hours per week of surveying practice the following year Six weeks of summer school
143	W Virginia Univ of	Land Surv	1.0.0	CE, EM	R	Fr	2	3	60	60	60	0	1926	Gillespie & B&H	A.M. Surv, computations, retracing old surveys
	"	"	1.0.1	EE, ME	R	Fr	2	1	20	20	20	0	—	—	C.L.T. Areas
	"	"	1.0.2	CE, EM	R	So	1	2	40	40	40	0	—	B&H	A.S. etc.
	"	"	1.0.3	CE, EM	R	So	2	2	40	60	60	0	—	J&S, & Tracy	Top, Hyd, Barometer, Mapping
144	Wisconsin Univ of	Elem Surv	1.2.1	CE	R	Fr	1	2	8	8	60	0	—	J&S	L. Computations. Also offered in summer school
	"	"	1.2.2	CE	R	Fr	2	2	8	0	60	0	1925	J&S	C.L.T.A.
	"	"	1.2.3	CE	R	So	1	3	24	48	24	0	—	J&S	T.P.A. Sx, Lat, Azimuth, Mapping, Pen Top. Planimeter
	"	"	1.2.4	CE	R	So	2	4	30	30	60	0	1926	J&S	Mine, Hyd, City, Mapping
	"	Geodesy	1.2.5	CE	O	Jn	2	3	32	0	16	0	1925	J&S	Δ Precise Level, Map Projections, Lat, Azim, Long, Time
145	Webster College	Elem Surv	—	—	—	—	—	3	54	0	108	0	—	B&H 2	C.L.T.S. Map, Meridian
146	Worcester Poly Inst	Land Surv	12.1	CE	R	So	1	—	16	64	80	0	—	J&S (not Middle Years)	—
	"	Surveying	12.2	ME, EE	R	So	1	—	0	64	—	0	—	Lee's Middle Surv Manual	Elective for Sr. Chemists
147	Wyoming Univ of	Surveying	12.1	Met E, Min	R	Fr	1	2	—	—	—	—	1926	J&S	C.L.T.A.
	"	"	12.2	Elective	R	Fr	1	2	—	—	—	—	1926	J&S	P.S. Continuation of 12.1
	"	"	12.3	CE, Min E	R	So	2	3	—	—	—	—	1926	R Field Exam.	Top, Hyd, Railroad Surv. part on mining?
	"	"	12.4	CE, Min E	R	So	2	3	—	—	—	—	1926	J&S & References	Mining & City surv. Elem geodesy and map projections Mining students here
	University (1)	Surveying	12.4	CE, ME, EE	R	Fr	Term	2	18	0	32	0	—	Jordan's Plane Surv.	C.L.T.A. Computations Rec. the periods varying with weather, Field 2 hr
	" (2)	"	12.5	CE	R	Jn	Term	7	72	30	75	0	—	—	P.S. Circ. curves, earthwork, top. Sx, Field Astr, R.R. Surv, maps with conventional signs
	" (3)	Elem. Surv	12.4	CE, EM	R	So	1	5	30	45	95	0	—	No special text	—
	" (4)	"	12.6	ME, EE	R	Jn	1	2	—	—	—	—	—	—	—
148	Illinois Univ of	Plane Surv	1.7	CE, ME, EE	R	So	1	3	27	9	18	0	1926	B&H 2, Davis-Field Manl	Land surveying, areas, plotting
	"	Higher	1.8	CE, EE	R	So	1	3	27	9	18	9	"	B&H 702, Davis-Field Manl	Top. surv, astronomical observations
	"	Plane	1.1	Landscape	R	So	1	3	27	9	18	0	1926	Raymond	—
	"	Top	1.2	"	R	So	1	3	27	9	18	0	"	—	—
	"	Elem	1.6	Civ. Engg.	R	Jn	1	3	24	12	10	0	—	Davis-Field Manual	Elementary problems, computing

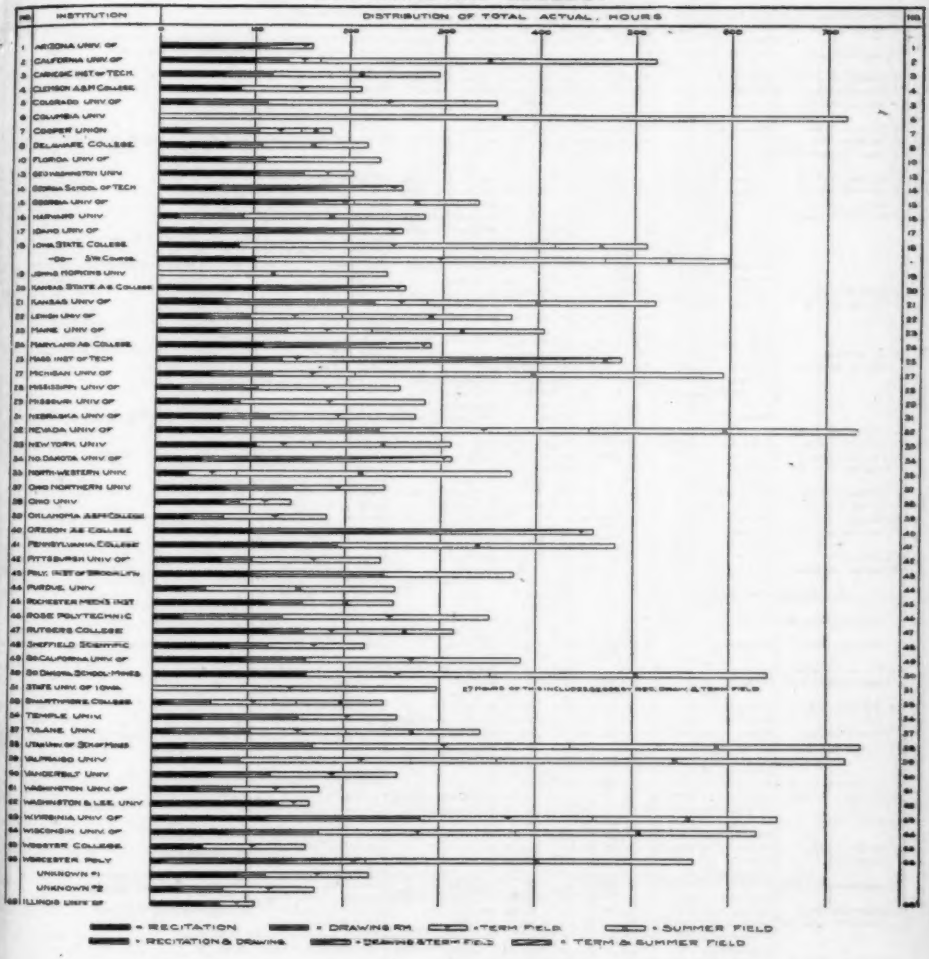
Notes:- Where dash is used no reply was made. Hours given do not include preparation

All work in surveying included exercises in pacing, chaining and ranging.

Text book abbreviations:- B&H= Breed & Hosmer, J&S= Johnson & Smith, R= Raymond, P&H= Pence & Hotchkiss

Abbreviations covering work done in following branches:- C= compass, L= levels, T= transit, A= adjustments, S= stadia, P= plane table, Sx= sextant, Δ= triangulation, M= meridian observations.

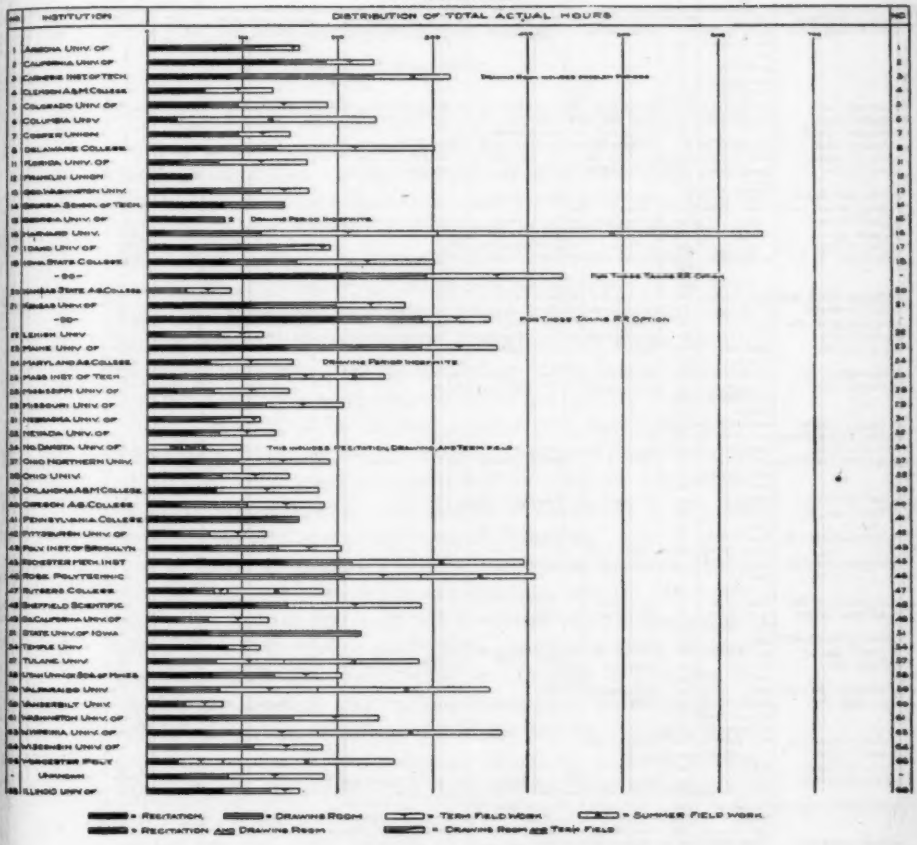
SURVEYING AND GEODESY



No.	Institution	Title of Course	Cat. No.	Engineering Course	Agric. Course	Year	Term	Hrs. per week	Hours Actual Hrs. per week			Text Book	Remarks
									Lec.	Lab.	Draw.		
1	Arizona, Univ. of	R.R. Surv.	1918	CE		Jr	Sum	4	32	128	0		Curves, Spirals, Earthwork & Tunnels
2	California, Univ. of	R.R. Surv.	1918	CE		Jr	1	3	34	0	51	0	Allen, Curves & Earth.	Curves, Spirals, Earthwork & Tunnels
	"	"	1918			Jr	1	1	0	51	0	0		Plotting surveys above [Lectures by Dist. Adams, Staff Comp. & Shadwell
	"	R.R. Eng.	1918	CE		—	Su	6	48	0	0	0	Sax Resorts	RR Option, economics, construction, signaling, interlocking RR locos, Wellington, Webb, Raymond, Crandall & Sm
3	Carnegie Inst. of Tech.	R.R. Eng.	1918	CE		Jr	Sum	4	34	102	0	80	Allen, Curves & Earth.	Curves, Earthwork, Spirals, Turnouts, Crossings, Drawing room, Compositions
	"	"	1918	CE		Jr	Sum	6	51	51	0	0	Raymond, RR Eng.	RR Economics, maintenance, signals, interlockings, etc
	"	"	1918	CE		Jr	Sum	6	51	51	0	0	Raymond, RR Eng.	Simple curves, spiral, vertical curves & earthwork, Drawing room, compositions
	"	"	1918	CE		Jr	Sum	6	51	51	0	0	Allen, Curves & Earth.	Simple curves, spiral, vertical curves & earthwork, Drawing room, Compositions
	"	"	1918	CE	Mining	Jr	Sum	3	24	24	0	48		One half of course (See # 157
	"	"	1918	CE		Jr	Sum	4	24	48	0	0	Raymond, RR Eng.	" (See # 157)
4	Clemson Agric. College	Civil. Eng.	1918	CE		Jr	Sum	3	—	60	0	72	Webb, RR Const.	Curves, location & earthwork
5	Colorado, Univ. of	RR Curves	1918	CE		Jr	Su	2	1	15	0	30	Allen, Curves & Earth.	Curves
	"	RR Eng.	1918	CE		Jr	Jr	1	5	48	32	64	Allen, Webb, Talbot, Raymond	RR Option, take 8 credits additional on location, economics, maintenance, maps, etc.
6	Columbia, Univ.	Civil. Eng.	1918	CE		R	—	—	2	0	0	0	96	RR room, prelim. location 2 to 3 hr. Law, yard & maintenance work
	"	"	1918	EM.	Mining	R	—	—	2	3a	0	0	48	" " " " "
7	Cooper Union	RR Eng.	1918	—		R	Su	10 2	—	60	35	58	0	— Allen, Curves & Earth	All of Allen & lectures on maintenance
8	Cornell Univ.	R.R. Eng. & Surveying	1918	CE		R	Jr	Sum	8	60	78	144	0	Sax Resorts	Curves, earthwork, location, economics, Webb, RR Co., Crandall & Barnes & Crandall Earthwork
9	Florida, Univ. of	Railroads	1918	CE		R	Su	2	18	34	0	34	Allen, Curves & Earth.	Curves, spirals, earthwork, crossings, eyes, Field work
	"	"	1918	CE		R	Jr	1	18	0	25	25	0	— notes	Prelim. location of 1 1/2 hr. law, maps, earthwork
10	Franklin Union	R.R. Curves & Estim.	1918	CE		R	Jr	Sum	—	45	0	0	0	Disp. & Notes	
11	Geo. Washington Univ.	R.R. Eng.	1918	CE		R	Jr	Sum	3	68	51	51	0	Allen, Baldwin	Curves, spirals, earthwork, prelim. location, map of RR, compositions & mass diagram
12	Georgia School of Tech.	Roads & R.R. Surv.	1918	CE		R	—	—	—	16	64	0	—	Allen, Searls	
	"	Road Engineers	1918	—					—	64	—	—	—	Raymond, RR Eng.	
13	Georgia, Univ. of	R.R. Eng.	1918	CE, EE		—	—	Sum	3	51	102	60	0	Allen, Baker, RR Section	RR Economics, spirals, switches
14	Harvard, Univ. of	R.R. Surv.	1918	—		O	—	—	1	20	100	185	0	Allen, Curves & Earth	Preliminary location, earthwork, mass diagram
15	Idaho, Univ. of	R.R. Eng.	1918	CE		R	Jr	Sum	6	48	144	0	0	Webb, RR Const.	Curves, Earthwork, location
16	Iowa State College	RR Location	1918	CE		R	Jr	1	3	51	76	102	0	Allen, Curves - notes	Location, curves and earthwork
	"	RR Const. & Maint.	1918	CE		R	Jr	2	4	34	68	136	0	Crandall & Barnes, Talbot, Raymond	Survey of existing railroads, yards and interlockings
	"	RR Eng.	1918	CE		—	Su	1	2	34	0	0	0	Notes	Electric railways compared to steam use o-beams and tunnels
	"	RR Signalling	1918	CE, EE		—	Su	1	1	17	0	0	0	Latimer	Interlocking and signalling
	"	RR. Design	1918	CE		—	Su	2	3	34	17	0	0	A.R.E. Proceedings	Design of yards and terminals, coaling and watering plants and treatment of water
	"	RR Operation	1918	CE, EE		—	Su	2	2	34	0	0	0	Notes	RR Operation
17	Kansas State Agri. College	R.R. Eng.	1918	CE		R	Su	2	4	0	40	48	0	No Text	R.R. Surv based on Raymond & Nagle
18	Kansas, Univ. of	R.R. Surv.	1918	CE		R	Jr	1	7	58	90	72	0	Allen & Talbot	
	"	RR Econ. Location	1918	—		—	—	—	3	54	0	0	0	—	
	"	RR Terminals	1918	—		O	—	—	2	36	0	0	0	—	
	"	RR Motive Power	1918	—		O	—	—	3	54	0	0	0	—	
	"	RR Surv.	1918	CE		R	Jr	2	4	17	60	45	0	— Allen, C.&E.	Required of all students taking railroad option
19	Lehigh Univ.	RR Curves	1918	CE		R	Su	2	3	34	0	34	0	— do	Expect to put field work in summer school
20	Maine, Univ. of	RR Curves	1918	CE		R	Su	2	3	38	0	38	0	— do	Curves and earthwork
	"	RR Const.	1918	CE		—	Jr	1	2	38	0	0	0	— Allens, Wilson's	
	"	RR Fields & Const.	1918	CE	Civil	R	Jr	1	2	0	48	48	0	— Allen's, C.&E.	Preliminary location and mapping
	"	RR Eng.	1918	CE		—	Su	1	3	48	0	0	0	— Raymond, R.R. Eng. Webb	RR Economics
	"	RR Eng.	1918	CE		—	Su	2	3	38	96	0	0	— Raymond, RR Eng. Crandall	RR Structures, Maps, locations from U.S. Coast Survey, turnouts and yard design
21	Maryland Agri. College	R.R. Eng. & Rec. Prac.	1918	CE		Jr	Spring	10	66	Incl.	88	0	176	Allen's C.&E.	Curves, location and earthwork
22	Mass. Inst. of Tech.	RR Field Meas.	1918	CE, S.E.		R	Su	—	—	30	120	30	64	— do —	
23	Mississippi, Univ. of	Surveying	1918	—		CE	—	Sum	3	30	40	80	0	Raymond, RR Eng. & Searls	Surveys for railroad and highway computation and estimates
24	Missouri, Univ. of	R.R. Surv.	1918	CE		R	Jr	1	3	51	102	51	0	Webb, Talbot	Curves and earthwork, turnouts and crossing
	"	R.R. Eng.	1918	CE		R	—	2	3	32	96	32	0	Webb	Earthwork, haul, hauling and economics
25	Nebraska, Univ. of	RR & Hwy. Surv.	1918	CE		R	Jr	1	3	17	102	0	0	Raymond, Field Course	Preliminary location, survey of railroad
26	Nevada, Univ. of	R.R. Eng.	1918	CE		R	Su	1	5	51	128	160	0	Nichols & Wiley	Curves, earthwork, location, railroad economics
27	N. Dakota, Univ. of	R.R. Eng.	1918	CE		R	Su	2	4	100	0	0	0	Several, None Required	Economics, location, curves, earthwork, railroads and maintenance of way
28	Ohio Northern Univ.	R.R. Surv.	1918	CE		R	Su	3	5	24	24	48	0	Searls	
	"	R.R. Economy	1918	CE		R	—	4	5	24	24	48	0	Wellington	
29	Ohio Univ.	RR Eng.	1918	CE		R	Su	1	4	51	24	72	0	Searls	Preliminary location, earthwork, curves & turnouts
30	Oklahoma A&M College	R.R. Surveying	1918	CE		R	Su	2	4	36	0	108	0	— Allen	Curves location, earthwork
	"	RR Eng.	1918	CE		R	Su	1	2	36	0	0	0	— Raymond's RR Eng.	
31	Oregon Agri. College	R.R. & Comm. Surveying	1918	Trans. Eng.		R	Su	2	5	34	72	51	0	— Allen	Curves earthwork, location
	"	R.R. Surv.	1918	Economics		R	Su	2	4	34	102	68	0	— do	" " " less field work than 272
32	Pennsylvania College	Railroads A	1918	CE		R	Jr	1	2	51	51	0	0	— Allen	
	"	" B	1918	CE		R	Su	2	1	34	0	0	0	—	Field work given in "Surv. B" [Coaling out work]
33	Pittsburg, Univ. of	R.R. Loc. & Const.	1918	CE		R	Su	Summer Camp	4	22	0	66	0	Allen	4 Terms per year. Summer Camp in future Curves, spirals, turnouts, crossings, eyes
	"	"	1918	CE		R	Jr	Jan. to Jun.	2	11	33	0	0	Crandall & Barnes	— do — — do —
34	Polytechnic Inst. of Brooklyn	R.R. Curves & Estim.	1918	CE		R	Jr	1	—	68	76	66	0	Allen & Lockwood	Everything on railroads
35	Rensselaer Polytechnic Inst.	RR Eng.	1918	CE		—	Jr	Sum	—	144	72	0	0	Allen	Entire book
	"	"	1918	CE		—	Jr	Summer	—	—	—	—	—	—	"
36	Rose Poly. Inst.	R.R. Surv.	1918	—		CE	Su	2	3	27	0	81	0	Nagle	Curves, spirals, earthwork, turnouts
	"	Practice in C.E.	1918	—		CE	Jr	1	4	18	162	0	0	Raymond, RR Eng.	Maps, design of structures, costs
37	Rutgers College	R.R. Eng.	1918	CE		R	Jr	2	—	60	30	60	100	Corbett's Curves & Earth.	Mason, prelim. location, curves and earthwork, spirals, turnouts, etc.
38	Sheffield Scientific School	R.R. Curves & Estim.	1918	CE		R	Jr	2	—	60	—	0	30	Allen	
	"	R.R. & Top. Surv.	1918	CE		R	Su	1	—	0	0	0	165	Allen, Thompson, Prater & Pinnell, Comstock	Location work, curves, etc.
	"	R.R. Mapping	1918	CE		R	Su	1	—	0	60	0	0	— do —	Mapping, compositions & earthwork
39	So. California, Univ. of	R.R. Eng.	1918	CE		—	Jr	Sum	5	32	32	64	0	Allen	Prelim. location, curves, earthwork, estimates & costs
40	State Univ. of Iowa	R.R. Surv.	1918	CE		R	Jr	2	3	0	162	0	0	Raymond, Field Course	Curves & Earthwork
	"	R.R. Eng.	1918	CE		R	Su	1	3	63	0	0	0	Raymond's RR Eng.	Economics & Maintenance
41	Temple Univ.	R.R. Curves	1918	CE		R	Su	Sum	1	51	0	0	0	Allen	
	"	Railroads	1918	CE		R	Su	2	1	34	0	34	0	Thurman	
42	Trinity College	R.R. Eng.	1918	Science		O	—	2	—	17	68	0	0	—	R.R. location theory, volumes, maps, Field work
43	Tulane Univ.	R.R. Surv.	1918	CE		R	Jr	2	3	18	0	60	0	Allen, Searls, Lewis	Curves, Reconnaissance, preliminary & location
	"	R.R. Maps & Estim.	1918	CE		R	Jr	2	3	10	120	48	0	— do —	Maps, earthwork, harmid, compositions, eyes, crossings
44	Univ. Utah or Sch. of Mines	R.R. Surv.	1918	CE, EE		—	Jr	Sum	6	68	68	204	0	Webb & Tratman	Curves, earthwork, turnouts, maintenance, construction and yard survey
45	Vanderbilt Univ.	Top. Eng. & R.R.	1918	—		CE	—	Su	1	1	24	32	108	Raymond, RR Eng. Nagle	Location, surveys, estimates, etc.
46	Virginia Polytechnic Inst.	R.R. Curves & Est.	1918	CE		R	Jr	2	3	32	8	60	0	Allen, Lewis	Curves, spiral, earthwork, 21% location optional for ME & CE
47	Washington, Univ. of	Const. Surveying	1918	CE		R	Su	1	3	16	16	48	0	Allen	Curves, earthwork, location
	"	RR Operation	1918	CE		—	Jr	1	3	32	24	24	0	Allen, Searls, Talbot, Raymond, Webb, Comstock	3 Spirals and turnouts and 1 RR Operation
	"	RR Location	1918	CE		—	Jr	2	2	16	48	16	0	Raymond, RR Eng. Crandall	Paper location, continuation course #31
48	W. Virginia, Univ. of	RR Location	1918	CE		R	Jr	1	3	64	64	80	0	— Searls	
49	Wisconsin, Univ. of	R.R. Curves	1918	CE		R	Su	1	4.5	0	64	24	0	— Allen, Talbot	Curves and spirals
	"	R.R. Loc. & Const.	1918	CE		R	Jr	1	3	0	48	48	0	Allen, Lewis	Preliminary location, maps, etc.
	"	RR Design	1918	CE		O	Su	2	2	—	—	—	—	—	Frog & switch design, resurvey of yards, maintenance survey
50	Worcester Poly. Institute	R.R. Eng.	1918	CALLE		O	Su	1	2	16	24	24	0	No Text	Allen	Curves, earthwork & location
	"	R.R. Curves	1918	CE		R	Su	2	—	32	0	48	80	— Allen	
	"	R.R. Surv.	1918	CE		R	Su	2	5	34	51	102	0	Nichols	
	"	R.R. Location	1918	CE		O	Ja	1	2	—	—	—	—	—	
	"	R.R. Curves	1918	CE		O	Ja	2	—	—	—	—	—	—	
51	Illinois, Univ. of	R.R. Surv.	1918	CE		R	Jr	1	5	80	50	30	0	Nichols & Wiley	Curves, location, earthwork, turnouts, switches, crossings, etc.

Note - Where dash is used no reply was made

RAILROADS


INSTITUTION
DISTRIBUTION OF TOTAL ACTUAL HOURS
NO.
1 ARIZONA UNIV. OF
2 CALIFORNIA UNIV. OF
3 CARNEGIE INST. OF TECH.
4 CLEMSON A&M COLLEGE
5 COLORADO UNIV. OF
6 COLUMBIA UNIV.
7 COOPER UNION
8 DELAWARE COLLEGE
11 FLORIDA UNIV. OF
12 FRANKLIN UNION
13 GEO. WASHINGTON UNIV.
14 GEORGIA SCHOOL OF TECH.
15 GEORGIA UNIV. OF
16 HARVARD UNIV.
17 IDAHO UNIV OF
18 IOWA STATE COLLEGE
- DO -
20 KANSAS STATE AG. COLLEGE
21 KANSAS UNIV OF
- DO -
22 LEHIGH UNIV
23 MAINE UNIV OF
24 MARYLAND AG. COLLEGE
25 MASS INST OF TECH
26 MISSISSIPPI UNIV OF
28 MISSOURI UNIV OF
31 NEBRASKA UNIV OF
32 NEVADA UNIV. OF
34 NO. DAKOTA UNIV OF
37 OHIO NORTHERN UNIV.
38 OHIO UNIV.
39 OKLAHOMA A&M COLLEGE
40 OREGON AG. COLLEGE
41 PENNSYLVANIA COLLEGE
42 PITTSBURGH UNIV. OF
43 POLY. INST. OF BROOKLYN
45 ROCHESTER TECH. INST
46 ROSE POLYTECHNIC
47 RUTGERS COLLEGE
48 SHEFFIELD SCIENTIFIC
49 So. CALIFORNIA UNIV. OF
51 STATE UNIV. OF IOWA
54 TEMPLE UNIV
57 TULANE UNIV
58 UTAH UNIVOF SCH. OF MINES
59 VALPARAISO UNIV
60 VANDERBILT UNIV
61 WASHINGTON UNIV. OF
63 WYOMING UNIV. OF
64 WISCONSIN UNIV OF
65 WORCESTER POLY
- UNKNOWN
66 ILLINOIS UNIV OF
Drawing Room includes English Periods
Drawing Period Indefinite
For Those Taking 5th Option
Drawing Period Indefinite
This includes Recitation, Drawing and Term Field
= Recitation
= Drawing Room
= Term Field Work
= Summer Field Work
= Recitation and Drawing Room
= Drawing Room and Term Field

Summer School Field Practice

Surveying, Geodesy and Railroads

No.	Institution	Students Attending and Year	Number Hours Worked Per Year	Place Where the Instruction is Given	Living Quarters	Mess is Operated By	Is a Summer Camp	Camp Equipment Furnished By: Students	Camp Equipment Furnished By: School	Expenses per Week: 1	2	3	4	Is Transportation Furnished	Other Courses Given
1	Univ of California	Civ. Engr.	320 h.Sch	Swanton, Cal.	Yes	Tents	School	Yes	No	Linen, Towels, Etc	Blankets, Camp Outfit	—	$3.00	—	0	No	No
2	Carnegie Inst of Tech	C.E.Sr.M.A Sum Sch	130	Summer Navy Pier	"	Tents	School	No	No	Linen, Towels, Etc	Blankets, Camp Outfit	$3.00	0	0	0	No	No
	"	Sum Alg Drawing	69	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	RR Jr CE	81	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	Geog Jr CE	33	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	Surv CE Hour	45	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	RR CE Hour	45	"	"	"	"	"	"	"	"	"	"	"	"	"	"
3	California Univ	All Courses Are In	25 Hours per week	Banta, Cohn	No	Summer	Contract	Yes	Yes	Blankets, Linen, Towels, Etc	Cot, Mattresses, Etc.	$3.00	—	Yes	No	$3.00	Yes
4	Cooper Union	C.E. 3rd Yr Hour	30	In City Parks	No	—	—	—	—	—	—	—	—	—	—	—	—
5	Delaware College		40	On Campus	No	Board No	Boarding No	No	—	—	—	—	—	—	—	—	No
6	Franklin Union	C.E. Stud.	36	On Vacant Prop	—	—	—	—	—	—	—	—	—	—	—	—	—
7	Univ of Georgia	Note:- Entire Student Body Hired Out For One Week Each Year. Students Must Take Three Weeks															
8	Harvard Univ	Summer Opt	220	Squam Lake, NH	Yes	Tents	School	Yes	Yes	Blankets, Linen, Towels, Etc	Camp Outfit	$4.00	$3.00	—	0	$3.00	No
	"	R.R. Opt	340	"	"	"	"	"	"	"	"	"	"	"	"	"	"
9	Iowa State College	C.E. Alone 2nd Yr. Hour	96	Short Line, Ia	No	Hotel	Hotel	—	—	—	—	$7.00	0	0	$3.00	$3.00	No
10	Lewis Hamphins Univ	C.E.M.E.E. Sum Sch	220	Campus	Yes	—	—	—	—	—	—	—	—	—	—	—	Yes
11	Univ of Kansas	Sum	240	5th Floor Campus	No	Tents	School	No	No	Blankets, Linen, Towels, Etc	Camp Outfit	$3.00	—	—	—	—	—
12	Lehigh Univ	Sum	178	Saucon Park, Pa	No	Hotel	Hotel	No	No	—	—	$10.00	—	No	No	$3.00	No
13	Univ of Maine	Jr	108	On Campus	No	Board No	Board No	Yes	Yes	Linen, Towels, Etc	Blankets, Camp Outfit	$7.00	$3.00	No	$3.00	$3.00	No
14	Mass. Inst. of Tech	Sec. 2nd & 3rd Yrs.	330 Hours	East Machias, Me	Yes	Tents	School	Yes	Yes	Linen, Towels, Etc	Blankets, Camp Outfit	$7.00	$3.00	No	$3.00	$3.00	Yes
	"	"	24	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	"	63	"	"	"	"	"	"	"	"	"	"	"	"	"	"
15	Michigan College Mines	Mining Students	640	Near Campus	No	Board No	Board No	No	No	—	—	—	—	—	—	—	No
16	Univ of Michigan	C.E. 3rd Year	384	Douglas Lake, Mich	Yes	Tents	School	Yes	Yes	Nothing	Blankets, Camp Outfit	$4.00	$3.00	$3.00	0	$3.00	No
17	Montana School Mines	Surv. Fr.	132	Chanages	No	Tents	Ranch No.	No	No	Nothing	Blankets, Camp Outfit	$4.00	0	0	0	$3.00	No
18	Univ of Nevada		280	Mining Camps	No	Tents	Mining Camp	No	No	Blankets, Linen, Towels, Etc	Camp Outfit	$4.00	0	0	0	$3.00	No
19	New York Univ	Surv. Sums	144	Webster Lake, Mass	No	Board No	Board No	No	No	—	—	$4.00	—	$3.00	0	$3.00	No
	"	R.R. Jr.	144	"	"	"	"	"	"	"	"	"	"	"	0	"	"
20	Northwestern Univ	All. Surv.	288	Lake Co, Ill.	No	Tents	School	No	No	Blankets, Linen, Towels, Etc	Camp Outfit	$4.00	0	$7.00	0	$3.00	No
21	Norwich Univ	Land Surv. Fr	130	Near College	—	Board	Board No	No	No	—	—	$3.00	$3.00	—	—	—	No
	"	Sum C.E.M.E. Jr.	180	"	—	—	—	—	—	—	—	"	$3.00	—	—	—	"
	"	R.R. Jr.	90	"	—	—	—	—	—	—	—	"	$4.00	—	—	—	"
22	Oregon Ag. College	Note:- Experience Gained in Practical Work															
23	Pennsylvania College	Sum. C.E. 1st Yr. Jr.	230	On Campus	No	—	—	—	—	—	—	$3.00	$3.00	0	0	$3.00	No
24	Purdue Univ	Sum C.E. Sr.	198	Appanoose, Miss	No	Hotel	—	No	No	Blankets, Linen, Towels, Etc	—	—	—	—	—	—	No
25	Rochester Mechanics Inst.	Sum C.E. Fr.	96	Suburbs	No	Board No	Board No	No	No	Nothing	Nothing	—	—	$3.00	No	$3.00	No
	"	Sum. M.E. Jr.	72	"	"	"	"	"	"	"	"	—	—	—	—	—	"
26	"	R.R. C.E. Jr.	180	"	"	"	"	"	"	"	"	—	—	—	—	—	"
27	Rose Poly Inst.	R.R. Surv. So.	120	Chanages	No	Board No	Board No	No	No	Nothing	Nothing	—	—	—	—	—	No
28	Rutgers College	—	100	—	No	Dorm	—	No	No	—	—	—	—	—	—	—	No
	"	Alds	50	"	"	"	"	"	"	"	"	—	—	—	—	—	—
29	Sheffield Scientific Sch	Surv. Fr. Term Jr.	130	Campus	Yes	—	—	—	—	—	—	—	—	$3.00	—	—	—
	"	R.R. Ter. 1st Term Sr.	173	Leased Land	—	—	—	—	—	—	—	—	—	—	—	—	—
30	No Dakota School of Mines	Surv. C.E. Sr.	198	Black Hills	No	Board No	Board No	No	No	—	—	$3.00	$3.00	—	0	$3.00	Yes
	"	Surv. C.E.	96	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	Surv. E.M.	144	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	Stevens Inst of Tech	Surv. M.E. Fr.	36	On Campus	—	—	—	—	—	—	—	—	—	—	—	—	—
33	Swarthmore College	Surv C.E. Sr.	36	Near College	No	Hotel	Hotel	—	No	Nothing	—	$3.00	$3.00	—	Yes	—	Yes
	"	Surv Others Sr.	48	"	"	"	"	"	"	"	"	"	"	"	"	"	"
35	Texas St. School of Mines	Surv.	288	On Campus	"	Doors	—	No	No	Nothing	Nothing	$3.00	$3.00	No	$3.00	No	No
36	Trinity College	Surv. Sr. C.E. Opt	60	Near College	No	Doors	Board No	No	No	—	—	$3.00	No	$3.00	—	—	No
37	Tulane Univ	Surv. Sr.	140	Mayfield La.	No	Camp	Camp	No	No	Blankets, Linen, Towels, Etc	Cots (only)	$3.00	No	$3.00	$3.00	$3.00	—
	"	R.R. Jr.	140	"	"	"	"	"	"	"	"	"	"	"	"	"	"
38	Univ of Utah Sch Mines	Min Sum C.E.M. Jr.	300	Various Mining Camps	No	Tents	—	No	No	Nothing	Nothing	$3.00	$3.00	$3.00	No	$3.00	No
39	Wabash Univ	Surv. 1st Term Fr.	180	Near Univ	No	—	School	No	No	—	Nothing	$3.00	$3.00	$3.00	No	$3.00	No
	"	Ter. Surv. 4th Term Fr.	180	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	R.R. 1st Term Sr.	180	"	"	"	"	"	"	"	"	"	"	"	"	$3.00	"
41	Univ of Washington	Note:- Expect to Start Camp in 1915															
42	Wash & Lee Univ	Note:- Should Have Six Weeks															
43	Univ. W. Virginia	R.R. Jr.	182	—	—	—	—	—	—	—	—	—	—	—	—	—	—
44	Univ of Wisconsin	Surv. Sr.	230	Devils Lake, Wis	Yes	Tents	Hotel	Yes	Yes	Blankets, Linen, Towels, Etc	Camp Outfit	$3.00	0	$3.00	$3.00	$3.00	No
	"	Note:- Railroad Camp Under Consideration															
45	Worcester Poly Inst	Ter. Surv. Sr.	120	City Parks	—	Board No	Board No	—	—	—	—	—	—	—	—	—	—
	"	Geod. Jr.	96	"	"	"	"	"	"	"	"	—	—	—	—	—	—
	"	R.R. 1st Term Jr.	180	Quantin, Mass	Yes	Tents	School	—	No	Blankets, Linen, Towels, Etc	Camp Outfit	$3.00	0	0	—	$3.00	No
47	Univ of Wyoming	Note:- Experience Gained In Practical Work															

"Camp Outfit" Includes Tents, Cots, Etc. But Not Blankets

Where Dash is Used No Reply Was Made

All Work Follows The Year Mentioned

Sheffield Scientific School of Yale Univ has recently purchased a camp site

APTITUDE AS A BASIS FOR EDUCATION.

BY SANFORD A. MOSS,

Lynn, Mass.

Is any useful purpose served by an attempt to gain proficiency in a subject for which one has no aptitude? Is something accomplished through the making of the effort, the training of the mind, and the actual results attained even though they be slight? A great deal of time is spent by high school and college instructors, by teachers of music and of art, with pupils who confessedly can never become experts. In an average high-school or college course where marks are given, many pupils obtain 70 or less, out of a possible 100, which usually indicates that they have no natural aptitude for the subject, and can never become really proficient in it. If all pupils who obtain less than 70 in the first quarter of a year's work in a given high school or college subject, were transferred to some other subject, a great change would be made in our present methods of instruction. The matter is, therefore, a very important one, and is well worth careful analysis.

A number of cases can be cited which demonstrate that a real problem is involved. As one example, take the two years' study of a modern language which most of our colleges require either before or during the college course, for many of their degrees. Such two years' study is supposed to give one an elementary speaking and reading knowledge. However, a census of any group of college graduates will show that a large majority are not able to make any actual use of their modern language. They can neither read, speak, or understand the language to the least extent in their post-college life. The writer has had close contact with about 100 new graduates from many of our leading technical colleges. All of these had two or more years' instruction in French or German, or both. About five of these men could make an intelligent translation

of a simple technical article. The other 95 could do nothing, or next to nothing. All of these men had spent many hours in preparation of their German or French lessons with the expectation that they would gain some useful result. I quote from the announcement of studies of a leading university:

"The object of this course is to give facility in translation, and especially to aid students in their later reading of technical and scientific works."

Another very common example is the case of algebra. Almost every person with a liberal or technical education has wrestled with this. He has studied division, multiplication, least common multiple, factoring, simple equations, and quadratic equations. Yet the average person cannot put down in algebraic form a statement of a comparatively simple problem. One often hears the remark: "I can solve that problem by arithmetic, but not by algebra."

Many graduates of high schools have had two or three years of Latin. This is supposed to assist them in the spelling of words of Latin origin, and to give them a clue to the meaning of words of Latin derivation. It is a matter of common notoriety that in many cases no such result is obtained.

All engineering graduates take courses in calculus. It is popularly supposed that an engineer makes daily use of this calculus instruction. This is far from being the actual case, however. Most engineering graduates are concerned with management of shops, production of machines, design of machines according to well-known principles established by long experience, manufacture of standard machines with minor changes to suit special purposes, operation of power plants, etc. A very small percentage have to deal with original engineering problems. Of these, another small percentage have to devise new solutions for problems which require a working knowledge of calculus. The average engineering graduate would be wholly at a loss to make an actual solution of an engineering problem which involved an original application of calculus. This, however, is not a disability for engineering work, since, the necessity for the application of calculus is as rare as stated.

It would be easy to add any additional number of examples to prove that a large percentage of those who pass in any high school or college course, have no real proficiency in the subject afterward. It is well worth while to make a serious analysis of this matter. It will not do to dismiss the whole subject with the usual statement that the training of the mind, and of the will power is a sufficient recompense for the time spent in a given subject, even though actual proficiency is not obtained.

First let us discuss the meaning of "natural ability," "aptitude," or "gift." Perhaps after all we can do no more than state that as a matter of common knowledge such a thing exists. In a class in high school or college, certain pupils do their work readily, and without any apparent effort. Others, in spite of hard work, get along indifferently. In any office, or shop, or other walk of life, similar situations are encountered. From a psychological point of view this matter is very interesting and puzzling. Possibly this aptitude belongs to our subconscious self, and it is our subconscious self that really has the proficiency. Modern philosophers seem to think that our subconscious selves instantly reach valid conclusions from a vast number of premises stored from past experience. This is without any conscious reasoning process or putting together of various premises in a laborious way and extracting the resulting conclusion. A proficient mathematician who sees a differential equation will instantly perceive a method of solution, without any effort at reasoning. One who has studied mathematics at length, but without a natural gift, if he has a good memory, will start to place the differential equation, to find out the class to which it belongs, and to note whether or not it is easy to separate the variables. After a tedious process of reasoning, each step of which must be gone through explicitly, he may finally arrive at the means of solution.

A naturally gifted mechanical engineer will, without any thought whatever, assign a size to a given machine part which makes it "look right." The actual computation of the size of such a part might require pages of computation. In fact, if it were not for such a gift, a designer would have to make com-

putations for every dimension of a machine, so that it might take several months to figure out all the sizes of a unit, even if a comparatively simple one. As it is, the designer computes a few of the principal dimensions, and makes the rest "look right." If he is a proficient designer, computation will show that the sizes thus determined really are right.

Similar examples could be given at any length from music, art, literature, or any of the fields of human endeavor. The philosophers say that our subconscious selves can only draw conclusions by making use of previous experience. That is to say, a person with a gift for mathematics must have instruction and experience in the various branches before he will be proficient. Hence, aptitude seems to be ability of the subconscious mind to store up memories in a given direction, and to make use of such of these memories as are necessary in a given case, and to reach a valid conclusion from them without explicit reasoning. This definition then means, that an aptitude is the ability to reach a conclusion without conscious reasoning; and lack of aptitude is the necessity for tediously going through each step in a chain of reasoning, and finally deducing the conclusion explicitly. In other words, a person with an aptitude does not have to think. Whether or not this theory is correct, the fact remains that we all know what aptitude means.

One may have aptitude in some directions, and wholly lack it in other directions. A high-school pupil who has an aptitude for algebra and trigonometry, may be very stupid in English and manual training. The commercial traveler who has the best sales record, may be very poor at computing the discounts and percentages of his price lists. The student of mechanical drawing, who can never produce a neatly inked and carefully arranged plate to the satisfaction of his teacher, may become a great designer of machinery, who employs many men like his former teacher to do the routine work of making drawings. A teacher often disposes of unproficient pupils with the statement that they have not the requisite mental power to understand a subject. This may be true to some extent. However, it seems highly probable that a large majority of people have profici-

ency in some direction or another. A teacher of algebra will call a boy lazy or stupid, who might be a vastly better brick layer than this teacher. It is notoriously true that many men who have secured low marks in theoretical courses in engineering, have had excellent success as professional engineers, and have often outstripped their fellows who received good marks in calculus. A dull pupil in chemistry may have great ability as a sculptor, and so on ad libitum.

It is obvious that training and development of a natural aptitude is highly desirable. One can most readily make a living where there is aptitude. The more an aptitude is developed, the greater the chance of general success. If a man has a general aptitude for engineering, and a special aptitude for mathematics, and if he develops himself along these lines, he can successfully be one of the comparatively few who need to do mathematical engineering. No time need, therefore, be spent on this side of the question. The other side of the question is the main object of our discussion. Should a mature mind make serious endeavor in a direction where there is no natural aptitude? This is the subject which we consider at length.

In some elementary cases it is, of course, necessary that this be done. One must learn to write, even though he can never become a good penman. A peasant must learn to read, even though he can never become a really literary person. On the other hand, a high-school pupil who has difficulty with algebra need not of necessity study it. A well-bred girl, who obviously could only become a mediocre piano player, need not take piano lessons. A young man whose natural aptitude leads him to study medicine, need only take enough Latin to write his prescriptions, and need not know how to translate Cæsar. We will not, therefore, take the time to make a fine-haired distinction between the cases where it is absolutely necessary to make endeavor in any direction where there is no aptitude, and where it is not. We will discuss only the case where an obviously inapt person studies a subject in which

proficiency is obviously not an absolute necessity, with the expectation of some other benefit.

Our thesis, then, is as follows: Should time be spent in study of a subject for which there is no aptitude, and which can give no direct benefit, for the sake of the indirect benefit in the way of culture, mind and will training? For example, if there is no aptitude for mathematics and no possibility that they will ever be directly used, should one who desires a good education learn trigonometry or algebra? Should an engineering student be required to pass in German and French if he is inapt? Should one who does not expect to be an archeologist or adept in literature, study Latin or Greek, if there is no aptitude?

Of course, there is a time-honored belief that all of these things should be done, or this article would need no writing.

It is written in the effort to demonstrate that there is no reason whatever for doing these things, and that the time-honored belief has no real justification.

The subject of "Valve Gears for Steam Machinery" is a very beautiful one to an enthusiast. The subject is rather complicated and requires much care and patience. Nevertheless, to one with an aptitude in this direction, it is exceedingly interesting. One without aptitude would be taught to do a great deal of thinking, would be taught concentration, and in fact would secure all of the advantages that are said to accrue from the study of Latin. Furthermore, the subject is much more important, and plays a much greater part in our modern civilization than does the subject of Latin. The valve gear is one of the principal parts of every locomotive, of every steamship, and of the engine of every factory which makes our clothes or food or electric light. Yet it is obviously absurd to put the question, "Should one who desires a good education study Valve Gears for Steam Machinery if he has no aptitude for it?"

Time is often spent on a subject for which there is no aptitude, with the expectation that aptitude can be obtained by labor. This is not true, however.

A person without aptitude can never make a real success of a subject no matter how long he may attempt to gain proficiency. We are all familiar with "wooden" piano playing, due to long study without natural gift. What we are calling natural gift or aptitude, would possibly be called by a musician "soul." A true musician rightly has a horror of music without this "soul." There can be just as much soul and artistic temperament in the driest kind of mathematics, or in the business of digging cellars. By sheer labor almost anything can be acquired, but there can never be true success without this elusive "soul." A boy may be taught to sharpen a wood chisel and to hold it in the proper way in his hands, but he can never be a wood worker unless he originally possesses aptitude. A master violinist may teach his pupil how to hold a bow in his hands, and how to hold his fingers in position for the various notes. The pupil may be able to do exactly as he should in all of these particulars, yet nothing is accomplished unless the pupil has the "divine fire."

Suppose one had a mixed class of babies and puppies, and set about teaching them to walk on two legs. He could teach them all something or other if he put enough time on it. Exactly the same situation exists in any of our classes in algebra for instance. There are some fitted to learn algebra just as well as a baby is fitted to walk on two legs. There are others fitted just as well as a puppy is fitted to walk on two legs. The thing can be accomplished with a given amount of labor, and by the time the puppy has become a dog, he can give a good demonstration. However, no really useful purpose results from teaching him to walk. He may be a perfectly good dog, and may be able to run and hunt, and do all the other things which a dog should do, but he is just as much out of his sphere in walking on two legs as the baby is at catching a squirrel.

So in our algebra class, after enough hard work, an inapt pupil may pass a final examination. If he cannot do it the first year he can repeat the course, and may pass in a second or third year, but he can never really use algebra. If he is

placed in some engineering position where algebra is required for the solution of problems, he can make no headway whatever as compared with his neighbor who is apt. If he remains in this position he will always be at a disadvantage and make no real success as contrasted with the other.

Suppose two men start together in a course of salesmanship, such as is provided by many of our large corporations for those who are to be sent out on the road as salesmen or drummers. They each learn equally well the various kinds of goods which they are to sell, and become thoroughly conversant with the good talking points of their own wares, and the demerits of the wares of their competitors. They learn their price-book by heart, and can recite any of the descriptions off-hand. They learn the psychology of selling, and all the other points which can be acquired. They start on the road and one soon begins to send in good orders, while the other makes no progress whatever. The writer has had personal experience with a case where this occurred, when the better salesman really knew the least about the goods he was selling. The poorer man had studied much more, and really knew more about his wares; yet he lacked aptitude and could make no real success.

A teacher often boasts that by his methods a pupil cannot fail to learn a subject. This means that he is patient and painstaking. He can drag his pupils along and make them learn a certain amount by heart, or in the same way that a dog learns to walk. As a net result, his pupils without aptitude pass his final examination. But this is the entire net result. He cannot create aptitude, and his pupils can make no successful use of the branch on which he has made them spend so much time. According to our usual standard, a good teacher is one who can readily impart knowledge. This usually means that he can present his subject in such a way that an inapt pupil can get something or other. His ability is a matter of little moment to the apt pupil however, who only requires that the teacher know his subject thoroughly.

Algebra as it exists in many of our high schools and col-

leges is confessedly given as a cultural study, with no pretension that the pupils are to make use of it. In fact most of the teachers themselves have no knowledge whatever of how algebra is really used by scientists. A true enthusiast in algebra, who had a natural gift, and who was well acquainted with the methods of using algebra in scientific work, would probably make a very poor teacher for such classes and be unable to impart his knowledge. If, however, we would retain in the class only those who really showed an aptitude at algebra, then our enthusiast would be able to give real instruction.

We must conclude, therefore, that aptitude is a real essential for successful use of a subject, and that no actual use can be made of a subject by an inapt person who attempts to make laborious study take the place of aptitude.

Another reason advanced for time spent on a study when there is no aptitude, is that the mind is trained.

If there is no aptitude for the study in question, training of the mind will be of no advantage in this particular direction. Obviously then, the object sought is training so that the mind can be better used in other directions in which there is aptitude. That is to say, a person apt at music and inapt at algebra, studies algebra in order that he may develop his mind so that he can study music to better advantage. Is not this absurd on its face? If there is aptitude in a given direction, why not train the mind to take advantage of this, by effort in the same direction? Concentration, memory, reasoning power, and all such general qualities can be developed in one way as well as in another. A good mathematician can have these qualities developed by study along mathematical lines, as well as by studying languages.

On the other hand, it is questionable if training of the mind in a direction where there is no aptitude, is of any advantage whatever in a direction where aptitude exists. A non-mathematical chemist will receive no training in reasoning out chemical formulas by an attempt to make him reason out problems in algebra. He will receive no training in

memorizing chemical formulas by an attempt to make him memorize dates in Greek history. He will obtain no experience in concentration on chemical matters which really interest him, by attempt at concentration on mathematical matters which are repugnant to him. He can only be taught to memorize, reason, and concentrate on chemistry, by memorizing, reasoning, and concentrating on chemistry, and not by memorizing, reasoning, and concentrating on algebra.

There are plenty of directions in any subject for which there is aptitude, in which the necessary training can be given, without necessity for going to some other branch, where there is no aptitude. A prospective lawyer can find numerous allied branches more or less interesting to him for use in mind training, without necessity for use of mathematics or Latin. There is almost, if not quite always, some direction or other in which proficiency exists, and general training of the mind can proceed in these directions. One can learn to think in a logical manner, and reason from cause to effect, by the concrete examples in a study in which he is apt, at least as well as in a study in which he is not apt. A future philosopher can be taught to think while he is being given instruction in philosophy, just as well as if he were given instructions in mathematics. A future statesman can be taught to think by means of political economy and history, just as well as by means of chemistry and atoms and molecules. It must be kept in mind that we are discussing merely the question of reasoning, apart from instruction in any particular branch. Syllogisms exist in political economy, just as well as in chemistry. Cause follows effect in music, just as it does in civil engineering. It is very doubtful if a non-mathematician makes any gain in clarity of thought by pursuing a mathematical subject in which he is more or less muddled all of the time.

Another reason given for time spent on a subject for which there is no aptitude, is to give culture, or breadth of view. A broadminded person is one who knows something about a great many different things. A narrow-minded person is one whose knowledge lies entirely along a certain groove. From

this point of view, it is desirable that one know something or other about a subject for which he is inapt. If this is the purpose, however, no attempt need be made to give proficiency in use of the subject. One can learn about a thing without trying to learn how to do it. One can learn about the tools used by an expert, without learning how to use these tools. If this idea were carried out, a much needed reform would be made in many classes. The subjects usually taught in elementary algebra are tools of the mathematician's trade. If one is to be a mathematician, he must learn how to use these tools. If, however, one has no mathematical aptitude, but simply desires to include in his broad education, knowledge of what the mathematician does, he need not try at all to handle the mathematician's tools. He can learn of the history of mathematics, than which no chapter in history is more interesting, or more important. The history of geometry; the story of Euclid (whose work has needed no essential change to this day); the beginnings of the Hindu and Egyptian geometers; the part that mathematics plays in the marvelous mechanical advances of today; and a host of similar items, will make good subject matter for pupils with non-mathematical minds. Study in these directions will do much more to give a broad view of mathematics than the memorizing of rules for multiplying trinomials and clearing equations of brackets and the other routine matters which are usually selected to give culture in a mathematical direction. Furthermore, study in such a direction will give much better mind training than the present methods. This situation is already recognized in many cases. In the case of music or art, no attempt is made to make a player out of a person who cannot carry a tune, or make an artist out of a person who cannot draw. One who can carry a tune, or who can draw is given instruction in all of the tools of the business. The others can be given considerable non-technical instruction regarding the character of the technical processes used by those who have inherent ability. No time is wasted in teaching them how to hold a pencil or handle a bow. In the case of chemistry, physics, languages,

and most other subjects, the fundamental aptitude or inaptitude is just as marked. Yet we throw all kinds of students together, and never seek to separate those who can actually *use* the tools of a subject, from those who cannot use them, but who can be given instruction in their general nature.

From this point of view, many high school and college courses could be given in two entirely distinct types of classes. One type would be for those who are proficient in a subject, and would be designed to teach actual use of it. The students should actually be taught to handle all of the tools. The other type of classes would be simply for giving instruction to non-proficient persons "about" the subject. No attempt would be made to make them actually use the tools. They would be taught what the tools were and how adepts used them and what they accomplished, as well as the history of the subject and its influences on civilization, etc.

The fact that there can be these two distinct objects in giving instruction should be fully recognized. A high school or college with such two types of classes would never retain non-proficient pupils. If, after a few months in a given class, a pupil did not do well, he would be required to leave that class and take up something else instead. The list of prescribed courses which every pupil must take whether or not he is proficient in all of them, would then be eliminated. Pupils would no longer take a given subject year after year in an effort to overcome it by sheer labor. If a student in mechanical engineering did not get on well in the class where use of calculus was taught, he would be excused from it, and allowed to take the other course where he would learn "about" calculus only. Of course, some equivalent must be required in each case where a pupil is excused from a course in which he is not proficient. There is great opportunity for such substitution. There are many things which a mechanical engineer can study to advantage if he is not proficient in calculus. There are many men well fitted to be mechanical engineers who are compelled to leave college because they are not proficient in calculus. Many of these afterward take up mechanical engineering

without their college degree and make a success, to the everlasting shame of their former college professors.

Many other similar examples can be given. For instance, one well-known technical college for many years had a course in Descriptive Geometry which was required of all engineering students, and which, due to the personality of the teacher in charge, was particularly strenuous. Many pupils had to take this course two, or even three times, before they finally passed. Many others left the college because they could not pass it. Other technical colleges not requiring nearly as much in Descriptive Geometry graduated men who had just as good success in after life.

Obviously then, nothing was gained by trying to make men who were proficient in other directions, take this particular course in which they were not apt. They could have gotten along just as well by being allowed to substitute some course for which they were adapted.

In another case, a leading university required ten hours of mathematics for pupils pursuing a liberal education. These pupils were put in the same classes in algebra, trigonometry, and analytical geometry, with engineering students, many of whom had to use these subjects for their life work. As a result many excellent scholars, teachers, and lawyers, who could not become proficient mathematicians, were barred from obtaining their degrees.

One very important result of the recognition of this matter of aptitude by our institutions of learning would be assistance given to pupils in finding directions in which they have aptitude. A beginning has been made in this direction by the so-called vocational schools, but the matter could go much further. Each course in high school or college could be arranged so that at a very early date, the apt and the inapt could be known and separated, and the proper arrangements made in each case. A pupil could have an opportunity to go from one subject to another until he had found something in which he could be really proficient. A requirement for graduation would then be a specified number of hours of study in any subjects in

which there was proficiency and which the pupil could actually make use of in later life. If desirable, another requirement could be a specified number of hours in any classes where instruction was given "about" things, without the requirement of proficiency.

There would then be two wholly distinct types of classes in subjects such as algebra, Latin, literature, chemistry, etc. These would presuppose respectively aptitude and inaptitude in use of the tools of the subject in performance of actual work. The classes for the apt would give instruction in the actual handling of the tools, and would require definite working out of problems, actual translations, actual analyses, or the like. The primary object would be to give the student facility in actual use of the subject matter. The classes for the inapt would treat the subjects merely as interesting branches of human knowledge and would show how the apt were using the tools. The primary object would be to give a general survey of the subject without attempt to give facility or proficiency in its actual use. Whatever training is needed for the thinking or reasoning power, or for the memory, would be secured in the subjects in which the student is apt. A liberal or special education laid out on such a basis would produce better results in every way than the present system, which attempts to give proficiency in a number of arbitrarily selected branches of knowledge regardless of the student's ability to obtain such proficiency.

OPPORTUNITIES FOR ENGINEERING EDUCATION IN THE SOUTHERN MOUNTAINS.

BY H. R. PHALEN,

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It is indeed a happy coincidence that just as the engineering and maufacturing South, after five decades of reconstruction, has obtained its "second wind" that the society represented by this publication should hold its annual session at the University of Virginia, and thereby augment the economic progress already under way.

The success of such a meeting cannot be complete unless all the phases of the southern situation are considered. Consequently, as a worker in an institution quite non-scientific but which does, nevertheless, engage yearly in teaching approximately eighteen hundred students the essentials of carpentry, masonry, forging, mechanical drawing and surveying, the author feels that simply by virtue of his connection with Berea he is able to illuminate from an unusual angle one possible function of the next assembly. If thereby any shall visit Charlottesville with a clearer understanding of a unique people from an obscure section the effort will not have been in vain.

The term "Appalachia" has been most aptly used in speaking of that rough virgin portion of our country lying in the mountain countries of the states of Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia and Alabama. Here is an area equal to New England and New York whose rugged character may be judged by noting that although the Atlantic States north of the Potomac can boast of but twelve mountain peaks over five thousand feet high and but one, Mt. Washington, over six thousand, this section claims forty-one over six thousand feet and two

hundred and eighty-eight over five thousand, to say nothing of hundreds of miles of ridges higher than Monadnock.

Hemmed in by such natural barriers is a people whose every-day life and social condition are silent but all-powerful invitations to every kind of education "to come over into Macedonia." A study of the thirty-five mountain counties of eastern Kentucky, which are typical of the whole region, will prove a revelation to those ignorant of the situation. Here, in a territory twice as large as Massachusetts, are five hundred and sixty-one thousand eight hundred souls among whom are but two thousand foreigners and thirteen thousand blacks. In only six counties do the blacks exceed one thousand and in twelve they are less than one hundred. Illiteracy varies from thirteen per cent. to thirty; none of the mountain schools have a term exceeding one hundred and fifty days and no child attends over seventy-five days (in this respect Kentucky is by no means the worst offender); no teacher gets more than $380 and no school building is valued at more than $900.

These figures may be readily verified by consulting the government bulletins or the records of this institution. In drawing conclusions, however, it must be borne in mind that there are many cultured, rich and educated people in the mountains. These have come in either through the agency of the lumber or mining industries or as social workers. It is sufficient to say that here and there will be found little hamlets where the leaven of social uplift is at work and the cause of humanity is advancing. One county in western Virginia possesses four elegant county high schools and has in addition bonded itself for $1,000,000 for macadam pikes.

What then is the field of engineering education in such a region? The discussion appears to fall into two parts; namely, the strictly engineering field and the educational and social horizon. The latter will be treated first.

No one notices with more gratification than the technical school graduate himself the fact that the old time conception of the engineer is passing and that whereas he was formerly supposed to be but a heartless automaton whose vocabulary

consisted largely of cuss words and formulae, he is now expected to conduct himself as a refined, scientifically trained gentleman—none the less an engineer but in addition a social or community physician, who seeks to obtain civic improvement in all directions by the judicious performance of his specialty and the tactful utilization of his leisure.

This is a new function of the engineer, but one which may expand to its maximum usefulness in Appalachia. The land and the people cry out for aid—for leadership—for advice. Such can only be given by him whose heart is big and who has sufficient culture to see many things outside his narrow sphere and possesses in addition the ability to remedy conditions with tact and foresight when such will produce better results than the application of the invariable laws of his profession. Upon entering some localities the technical graduate will find himself the only being in a village of several hundred souls who has attended school more than a year. Under such circumstances he will do one of two things depending upon his undergraduate mode of life. Either he will be a recluse with the exception of a few saloon brawls for excitement or he will be a factor for higher civic and educational ideals. The mountain people are not readers and they do not know how to play. Instead they rehearse in the store, the barroom, even at the fireside in the presence of the toddling children the shooting escapades of the feud and the still. Concerted community action for local improvement is unknown, the only incentive to social intercourse is the intolerant sectarian church, the rank partisan political rally or the inane party where until recently kissing games are the fashion for all ages. The new and welcome type of engineer may here function, not necessarily as a missionary but at least as a Christian gentleman.

"But what specific things are there in this section," the reader reflects, "to even call the engineer, much less to establish a technical school?" A glance at present conditions reveals not only the future possibilities of this great field but gives crying evidence also of the entire absence of scientific practice in the past. What would the sanitary engineer say

concerning a rural hotel which is so built that the toilets (in reality the old-fashioned privy) are directly over a slow moving and shallow creek which is forded in two places by main streets of the village. At this stream the pigs, sheep, horses and in fact all live stock drink freely and later in the autumn butchering season become staple articles of food. Bridges are few and no one cares for the condition of the highway. Many country roads follow the bed of a stream for miles over the slate layers that rise and fall in step formation frequently as much as fifteen inches at a time. Obviously such a road is useless during the rainy season. In many sections no attempt is made to maintain other than a path for saddle horses. Along with the growth of mining and lumbering there has come an increased demand for reasonable hauling cost, a thing which will soon call forth better roads and will elicit the aid of the highway engineer. The great Dixie Highway now under construction from Chicago and Indianapolis to Atlanta is one other indication of the trend of affairs.

Another source of constant difficulty is the possession and transaction of real property. Some of the mountain regions and eastern Kentucky in particular never were surveyed by the government. Kentucky was a county of Old Virginia and was doled out piecemeal under the iniquitous land grant system to the perpetual annoyance of all concerned "even unto this day." The writer has it upon first hand authority that a certain real estate company purchased a large tract of land in a particular county. The deeds were verified by the county surveyor, but notwithstanding, it was found upon legal examination that these titles covered not only fifty-thousand acres more than the total area of the county but in addition included the whole township in which the county surveyor lived and had his home. Surely the clearing up of such conditions is the work of a man of good judgment and precise training. Large interests are continually soliciting the aid of well-trained surveyors to adjust similar disputes.

The mining and agricultural situations are also nuts that demand technical cracking. The mineral deposits are numer-

ous and in most cases workable but are largely unknown. Gold, silver, iron, petroleum, fluospar and copper have been found in paying quantities while lead, zinc, barytes, gypsum and even diamonds have been discovered but not exploited.

The agricultural conditions are daily becoming worse and will soon be beyond the aid of even the experienced forester. The greedy lumberman and the destitute mountaineer have met with disastrous results.

Coal and its byproducts immediately attract the chemical engineer while all these activities together with a vast amount of quarrying look to the electro-mechanical engineer for a solution of innumerable difficulties.

The whole situation is summed up in a word. Here is a rich section which is being exploited by the corporation devilfish on one hand and by mediocre people with antiquated means on the other. The former doesn't care and the latter doesn't know about conservation.

Under such conditions isn't it possible that Appalachia would support a technical school and isn't it possible that such an institution if properly operated would serve the double purpose of extending scientific education and of saving the mountaineer from himself?

The success of the venture would depend very largely upon two things, the first of which would be an absolute recognition of the fact that it is only the mountain boys themselves who, on account of their love for home, can return and benefit the native community. The "hill Billy" is a great family man who regards all strangers as foreigners and trusts and loves only his kinfolks. Consequently the school which persists in sending city engineers into the hills can never hope to enjoy more than partial success, and that such as it may be, will be solely technical and accomplished against perpetual opposition. The mountaineer doesn't want the railroad—he suspects the khaki-clad "city feller" but if Jim Wilson's boy Hank or Long Jake's Bart comes home with an education and makes things happen that never happened before the whole village is interested. The first hypothesis then is that any oper-

ations along technical lines in this section must be made by and not on the natives.

The second point is the realization that success depends upon adaptability. Many educators are such sincere worshipers at the shrine of the god of "Things as They Think They Ought to Be" that they totally forget the little fetish of "Things as They are." The analogy will be clear when the reader is reminded that the mountain problem cannot be hung on a classified peg with other types of educational endeavor. Stereotyped methods of teaching fail utterly because they have been devised for and practised upon generations of college students who never have thought for themselves. They don't go—they are sent. The mountain student, however, comes with the will to learn and the bodily vigor to work hard. Naturally the situation is quite different from the common experience of professors and it no doubt would please some of them to feel that their customary application of the educational pulmotor was unnecessary.

Moreover the Appalachia educator must hold before him continually the idea that a technical school in this region is for the benefit of the mountain people and not a means of producing more sweat shop material for the exploitation of the big corporations. This is a radical departure from the commonly accepted function of an engineering school but the testimony of hundreds of technical graduates who are five and even ten years out of college and still are "broke" would seem to indicate some weakness in the present system. The success of the enterprise now under consideration depends upon the constant instilling of the desire to return to the mountains and there work out the great multiplicity of local problems. Such a propaganda is possible of operation because Berea now returns 85 per cent. of her students to the hills and that represents very nearly 100 per cent. of the mountain enrollment.

In conclusion let it be impressed upon the lowland metropolitan educator that the immediate need of Appalachia is not a grand influx of expert engineers whose sole interest is their profession. A few, a very few, may be required but the great

present necessity is a technical school which shall infuse into mountain community life the red corpuscles of economic, social and civic improvement by making of itself a source from whence shall come year after year a stream of technically trained native sons. Such need not be experts. It would be advisable to have the first few college generations possess rather a practical than a theoretical knowledge. The leaven must be set by those who have not been educated to the point where the personal touch with the home folks has been lost. In a word then, the highland educator must commit himself to the proposition that those institutions which so desire may vie with each other in producing inventors and task masters for frenzied industry, but his work shall be the redemption of a land which can only be saved by its own people. The time is ripe and the call great for him who has the vision of such a master stroke of conservation and progress.

AN EXPERIMENT IN THE EVALUATION OF A DEFINITE INTEGRAL BY DIFFERENT METHODS.

BY LEONARD M. PASSANO.

Two of his colleagues submitted to the writer the integral which will appear in the following discussion as an example of the kind of integral occurring in their engineering practice. They asked whether the integral could be more quickly evaluated by actual integration or by some method of approximation, suggesting for the latter the construction of the graph of the integrand and estimation of the area under the curve. As a teacher of mathematics the writer could give but one answer: the greater efficacy of actual integration. Having made this reply he proceeded to investigate by experiment upon himself and upon two sections, or classes, of students of the Massachusetts Institute of Technology.

These students were a heterogeneous group from various courses: Architecture, civil engineering, mechanical engineering, electrical engineering, business administration. They composed two sections, of average ability and industry, in the sophomore class, and had nearly completed a half-year course in integral calculus. The problem under discussion was assigned to them as *voluntary* work for the Christmas vacation. No regular work was assigned for the holiday, and the men were told that those who solved the special problem might omit a certain set of problems which were a part of their assigned home work. It was explained to the men that the integral in question occurred in engineering practice and that the results of the investigation might prove of interest and value in their professional work. It was hoped that interest in their work as well as intellectual curiosity would induce the students to make a serious effort.

The following cyclostyled sheet was given to each man.

THE PROBLEM.

Evaluate

$$t = \int_2^4 \frac{500{,}000}{1{,}000 - 70H^{3/2}} dH$$

1°. By integrating.

2°. By computing

$$\sum_2^{4-\Delta H} \frac{500{,}000}{1{,}000 - 70H^{3/2}} \Delta H$$

at intervals $\Delta H = \frac{1}{2}$.

3°. By drawing the graph of

$$y = \frac{500{,}000}{1{,}000 - 70H^{3/2}}$$

and estimating the area bounded by the curve from $H = 2$ to $H = 4$.

Result to four figures.

Wanted:

Time required for 1°, 2° and 3° separately.

May use text-book, log tables and slide-rule.

The men were told that they might consult their text-book in determining what method of integration to use, but that only time actually employed in the integration was to be counted in the experiment. They were reminded that any logarithms occurring would be Naperian logs, and that any angles must be in circular measure. No other instructions or information were given except, of course, that each man must do the work alone. No hint was given as to the value of the integral.

In the meantime the writer solved the problem in the three ways required, working diligently but without haste. The results of his work are shown in Table I.

TABLE I.

	Method.		
	I.	II.	III.
Result	1,631	1,640	1,623
Time*	96	32	60
Ratios of times	3	1	1.9

* Times throughout are in minutes.

The number of students to whom the problem was given was 39; the number from whom returns were received was 24, or 62 per cent. The writer believes that the difficulty of the integration rather than lack of interest deterred many of those who made no returns, although intellectual interest which will not surmount difficulties is of very small value. Table II gives the results of the students' work.

TABLE II.

Method.	Result.			Time.			Ratios of Times.		
	I.	II.	III.	I.	II.	III.	I.	II.	III.
Name *A*	..	1,515	1,635	[70]*	24	30	..	1	1.25
B	..	1,507	1,427	..	60	65	..	1	1.1
C†	..	..	..	[ ]	..	[ ]	..	..	..
D	..	1,508	..	..	20	..	..	1	..
E	..	1,108	1,110	..	25	35	..	1	1.4
F	1,654	1,535	1,628	65	14	48	4.6	1	3.4
G	1,649	1,638	..	120	20	..	6	1	..
H	..	1,498	1,582	..	10	80	..	1	8
J	..	1,510	1,600	[120]	60	60	..	1	1
K	..	1,510	1,600	[210]	75	60	..	1	0.8
L	..	1,051	922	..	17	33	..	1	1.9
M	..	1,510	1,605	..	35	65	..	1	1.9
N	..	1,510	1,604	[50]	30	30	..	1	1
O	1,655	1,512	1,630	188	29	23	6.5	1	0.8
P	..	1,512	1,567	..	25	40	..	1	1.6
Q	..	1,048	..	[180]	17	..	..	1	..
R	1,629	1,512	1,579	240	60	120	4	1	2
S	..	1,508	1,550	[180]	150	60	..	1	0.4
T	..	1,510	..	[240]	90	..	..	1	..
U	1,560	1,445	1,501	120	30	40	4	1	1.33
V	..	1,512	1,499	..	30	43	..	1	1.4
W	..	1,485	1,531	[155]	60	20	..	1	0.33
X	1,632	1,529	1,548	210	30	20	7	1	0.67
Y	..	1,641	1,642	[150]	60	105	..	1	1.75
Total no.	6	23	19	..	Average		5.4	1	1.7

* Bracketed times mean no result obtained.

† Student *C* handed in work without times and without results.

Tables I and II show, as might have been predicted, that the second method (approximate summation) has a decided advantage over the other two as to the rapidity with which results may be obtained. It may be noted that the range of deviation from the average relative time is

Δ I -1.4 to $+1.6$, Δ III -0.97 to $+2.1$

The writer will venture to call his own results, given in Table I, the standard. Thus, standard I is 1,631, and so on. The average of these standards is 1,630.* Table III shows the accuracy of the results obtained by the students as compared with the standard.

TABLE III.

Result correct to within 1 per cent. of average, 1,630; *i. e.*, between 1,614 and 1,646.

Method	I	II	III
Number obtaining	2	2	4

Result correct to within 1 per cent. of separate standards.

Method	I (1615–1647)	II (1624–1656)	III (1607–1639)
Number obtaining	2	2	3

Result correct to within 2 per cent. The numbers are the same for both the average and separate standards.

Method	I	II	III
Number obtaining	5	2	8

Five men solved the problem by all three methods. Table IV shows the accuracy of their work.

TABLE IV.

Percentage Error from Average Standard.

	Method.		
	I.	II.	III.
Name *F*	+1.5	− 5.8	−0.1
O	+1.5	− 7.2	0
R	−0.1	− 7.2	−3.1
U	−4.2	−11.3	−7.9
X	+0.1	− 6.2	−5.0
Average	1.5	7.5	3.2

Tables III and IV would seem to indicate that method II is inferior to I and III in point of accuracy. That this con-

*It may be noted that the result obtained, using the graphical method, by the writer's colleagues was 1622, "the fourth figure being doubtful."

clusion is false the writer believes is shown by the following considerations. If in making the summation the inferior series is used (omitting the highest term) the result is 1,512. If the superior series is used the result is 1,768. The mean of these two is 1,640. Many of the students, using only one series, obtained exactly, or very nearly, 1,512. Only two men used both series. The students had had some slight practice in such summations, approximating closer by using smaller intervals, and had almost invariably worked with the lower series, although the method of the mean had been mentioned. It may be presumed that a student who calculated the lower series correctly would also have obtained the superior result and the mean correctly, with additional time. Now it took the writer 26 minutes to compute the inferior value; six minutes additional to compute the superior value and the mean; an increase of 23 per cent. If we increase the method II times by 23 per cent., for all men except those who used both series, we

TABLE V.

Method.	Time.			Relative Time.		
	I.	II.	III.	I.	II.	III.
Name* *A*.....	...	30	30	...	1	1
B.....	...	74	65	...	1	0.9
E.....	...	31	35	...	1	1.1
F.....	65	17	48	3.8	1	2.8
G.....	120	20	...	6	1	...
H.....	...	12	80	...	1	6.7
J.....	...	74	60	...	1	0.8
K.....	...	92	60	...	1	0.7
L.....	...	21	33	...	1	1.6
M.....	...	43	65	...	1	1.5
N.....	...	37	30	...	1	0.8
O.....	188	36	23	5.2	1	0.6
P.....	...	31	40	...	1	1.3
R.....	240	74	120	3.2	1	1.6
S.....	...	185	60	...	1	0.3
U.....	120	37	40	3.2	1	1.1
V.....	...	37	43	...	1	1.2
W.....	...	74	20	...	1	0.3
X.....	210	37	20	5.7	1	0.5
Y.....	...	60	105	...	1	1.8
			Average.	4.5	1	1.1

* *C*, *D*, *Q* and *T* omitted.

shall have a more just basis of comparison for the three methods. This is done in Table V.

The advantage in time lies still with method II, while the advantage in accuracy is markedly in favor of this method. This is shown in Table VI, which gives percentage accuracy.

TABLE VI.

	Method.		
	I.	II.	III.
Name *A*	..	1	1
B	..	1	15
D	..	1	..
E	..	30	35
F	2	2	1
G	2	1	..
H	..	1	5
J	..	1	2
K	..	1	2
L	..	35	45
M	..	1	2
N	..	1	2
O	2	1	1
P	..	1	5
Q	..	35	..
R	1	1	5
S	..	1	5
T	..	1	..
U	5	5	10
V	..	1	10
W	..	2	10
X	1	2	5
Y	..	1	2

Thus the figure 1 means an error of not more than one per cent. of the standard; 2 means an error greater than one per cent. and not greater than two, etc. Table VII gives the percentage of men obtaining the result to within one per cent., etc., and table VIII the average time of these men. Table IX gives the same data grouping the men in only two groups.

The evidence seems to the writer conclusive that method II, approximate summation, is the best. That method shows the greatest percentage of men with small error and with a moderate time. However, method III, the graphical method, shows a marked advantage in time though the percentage of

TABLE VII.

Percentage of Men Obtaining Result.*

Method.	0% to 1%.	1% to 2%.	2% to 5%.	10% and Over.
I.	33	50	17	0
II.	70	13	4	13
III.	16	26	26	32

* Percentage, that is, not of the total number of men, but of the number making returns by the method in question.

TABLE VIII.

Average Time for Results.

Method.	0% to 1%.	1% to 2%.	2% to 5%.	10% and Over
I.	225	124	120†	..
II.	59	29	37†	24
III.	34	64	64	39

† One man.

TABLE IX.

Method.	Per Cent. Obtaining.		Average Time.	
	2% or Better.	Over 2%.	2% or Better.	Over 2%.
I.	83	17	165	120
II.	83	17	56	28
III.	42	58	53	51

small-error men is low. One man only, *X* of table VI, obtained a more accurate result by the first method than by the second.

The writer does not, in any sense, wish to be understood as advocating the exclusive or predominant teaching of methods of approximate summation to classes in mathematics. Integration is too important, both in itself and in its applications, to be in any way neglected or subordinated to other methods, however useful the latter may be in engineering practice. But since integration is summation, and since it is of the utmost importance that the student should thoroughly grasp that fact, it would seem that time spent in approximate summations might serve the double purpose of emphasizing the meaning of integration and of supplying a useful method for engineering practice.

A PROPOSED NEW ELECTRICAL ENGINEERING TEXT-BOOK SERIES.

BY J. C. CLARK,

Assistant Professor of Electrical Engineering, Stanford University.

In recent years electrical engineering instructors in all quarters of the country have manifested a high degree of dissatisfaction with the available electrical engineering text-books. Many instructors have found it advisable to try a different book each year. Some, especially among the older men in the profession, have apparently abandoned all hope of discovering the suitable book and are resorting to the use of various substitutes for it. Occasionally we find an electrical handbook in use as a text. Sometimes there is used a system of references to literature by the aid of which students are expected to fill in the details of a structure supplied by the lecturer. Rather frequently, we find the use of a more or less complete syllabus prepared by the instructor to accompany his lectures. One witnessing this general situation quite naturally asks: "Can it really be true that the available text-books fail so signally in meeting the needs of modern electrical engineering instruction? If it be true, how can it be explained in view of the fact that, almost without exception these texts are the product of men actively engaged in the teaching profession?"

So many interesting books designed to serve as elementary texts in electrical engineering have appeared within the past few months that it might now seem to be a finicky instructor indeed who would still find difficulty in selecting from the published array of text-books at least one or two books very well adapted to the needs of his students. However, judging from the difficulty which electrical instructors have experienced in the past to find texts suitable for their classes, and also from the fact that the new books appear to possess very few, if any, marked points of difference from most of

their forerunners, the writer entertains very little hope that the situation will be appreciably better in the near future. Accordingly, in the belief that discussion of the matter of suitable electrical engineering texts will be beneficial, he ventures to outline in this paper what appear to him to be desirable characteristics in a proposed new text-book series for use in the ordinary four-year course in electrical engineering.

It will first be assumed that the more technical electrical courses to be given by the electrical faculty are confined entirely to the study of the fundamental principles of the electric and magnetic circuits as exemplified in the apparatus of heavy electrical engineering.* There can be little doubt of the wisdom of confining instruction to fundamentals in the ordinary course and with ordinary students. The leaders in industrial life have differed much on minor details of educational policy, but their discussions of engineering education uniformly insist upon the discarding of "informational" courses and upon thorough training of students in the fundamentals. Moreover, from studies of the occupations of electrical engineering alumni of several representative institutions, it would seem wise to avoid any specialization within the ordinary course. Electrical engineering is an exceedingly diversified subject; and, with the rapid extension of electrical methods in the industrial world, it seems entirely safe to predict that all engineering is before long to become *electrical* engineering. We cannot possibly hope to provide efficient courses to train men in the details of a hundred special applications of electricity in engineering, and yet we know that they will go into hundreds of different

* The term "heavy electrical engineering" is here used to designate a somewhat different class of apparatus from that included by Hobart in his book "Heavy Electrical Engineering." For the purposes of this paper, "heavy electrical engineering apparatus" is taken to include all dynamo-electric machinery; all transformers or converters; and the electrical features of transmission or distribution systems, and of apparatus for storage, switching, controlling, and regulating.

callings. Then why not design our courses and our text-books with these facts in mind?

The writer believes that there is need, in a properly conducted electrical engineering course, for a text-book series of a rather new type. It will be assumed that the series consists of two books (although it might prove desirable, as a matter of expediency, to further subdivide each book into parts). These two books will be designated hereinafter as Book I and Book II. In what follows, certain highly desirable characteristics for either book to possess are first specified, then follow further detailed specifications for each book.

General Specifications for Either Book.

1. It shall bear a title truly indicative of the nature and scope of the book.

2. It shall be *usable* as a text-book. To this end, it shall be written by a man of much teaching experience, and the contents shall have demonstrated their worth by previous successful service in the class-room of the author.

3. It shall contain enough carefully designed problems inserted after each article so that there will be no need for a separate "problem book."

4. It shall be capable of service as a laboratory guide; *i. e.*, it shall be of service to the student in planning his own experimental work for the purpose of checking theory.

5. It shall be written in such a spirit as to stimulate the student to further reading and study of the details of the subject.

Further Specifications for Book I.

1. This book shall constitute a genuine introduction to the subject of electrical engineering; *i. e., electricity in engineering.* From this viewpoint, it shall contain a variety of topics calculated to develop true perspective in the mind of the student as to the place of electricity in modern industrial life. There shall be given a very exhaustive outline of the field of electrical engineering. In this outline the emphasis shall be

placed on the present and the probable future, rather than on the historical development of electrical engineering. As one suggested means of accomplishing this result, curves may be presented and discussed showing the rate of change in recent years of such items as the following in a number of the industries largely employing electrical methods: capital investment, gross earnings, net earnings, total number of employees, number of engineers employed, amount expended per annum in scientific research and new design.

2. It shall develop the broader physical principles employed in a wide variety of electrical apparatus,—not confining the treatment to the apparatus of heavy electrical engineering, but giving due importance to the applications of electricity in lighting, heating, chemistry, intelligence transmission, etc.

Further Specifications for Book II.

1. This book shall give the student a very thoroughgoing analytical treatment of the electric and magnetic circuits. This treatment shall be mathematical, employing calculus freely when desirable to do so, but it must relate the mathematics at all points clearly and intimately with the *physics* of the subject. It shall continually illustrate the working out in the apparatus of heavy electrical engineering of the principles governing the actions and interactions of the electric and magnetic circuits.

2. By means of rather exhaustive and very carefully selected references to the literature, this book shall point the way by which the student may acquire a more detailed knowledge of the subject, in so far as such knowledge can be obtained from the literature. Such references shall be placed as footnotes to the text at points where the need for them arises—they are not to be ranged in formidable lists at the ends of the chapters.

The subject of "Commutation" is here discussed briefly in order to illustrate in a general way the scope of the treatment

to be desired within each book of such a detail topic from heavy electrical engineering.

Book I should describe clearly the function of a commutator. It should indicate the reasons for the difficulties encountered in commutation, hence it should be accompanied by an elementary discussion of the phenomena of self-inductance, armature reaction, and methods of compensating for armature reaction. It should not only give a clear drawing of a common type of commutator, but it should also emphasize the fact that a commutator may take a very wide variety of proportions in machines designed to meet various demands of practice. After having mastered the treatment of commutation in Book I, the student should be able to operate commutating machinery with confidence in his ability to remedy the commoner kinds of troubles with commutation by the intelligent application of his knowledge of the fundamentals of the subject.

Book II should assume, obviously, that the student is ready, by virtue of the preparation afforded by Book I, to undertake a careful analytical study of commutation based on a thorough knowledge of the fundamental physical factors involved in the process. There should be no place in a book of this type for empirical or semi-empirical "criteria of commutation," but there should be a simple application of the principles of the electric and magnetic circuits. The limits in various directions of our knowledge of the process should be clearly indicated, and at these points suggestions should be made as to lines of research designed to provide the information necessary to remove such limits.

In the writer's opinion the use of Book I could profitably be continued throughout the later years of the student's college course for the purpose of maintaining in his mind the perspective established in the earlier more intensive use of this book. Such use should require a very small amount of time, but the best results could only be secured by entrusting the conduct of the class to a man of wide experience in engi-

neering and teaching. Without doubt the study of Book II should continue throughout the junior and senior years.

The writer does not claim much novelty for each of the books herein advocated. Most progressive teachers know of available books which will almost, if not quite, meet the specifications for Books I and II. *Yet these books are not widely used.* It would seem probable, therefore, that many instructors will deride the idea that two such simple books will best answer the needs of modern instruction in electrical engineering. This will but illustrate the greatest weakness of our engineering courses. We are so anxious to build the highly elaborated superstructure that we are not patient enough to build well the foundation—yet the time suffices only to build the foundation. The writer does not belittle the value of specialization to those who are really fitted to undertake it, but what can possibly justify specialized courses for the undergraduate? Nor does the writer presume that he has completely solved the problem of a proper text-book series. He will, however, feel amply justified in presenting his views if they but lead to a more thorough discussion of the problem.

FIELD WORK IN HIGHER EDUCATION.

BY PROFESSOR F. B. ROBINSON,
The College of the City of New York.

Fifty years ago, the laboratory method was finding a place in college departments of natural science. To-day no one doubts the necessity of laboratory practice in chemistry, physics, all the branches of natural history and even psychology. The educational doctrine that we learn by doing has become generally accepted and experts have been busy perfecting laboratory exercises which will organize, in most convenient and trustworthy form, the things a student should do to make most rapid progress in certain fields of learning.

Just now there is a widespread agitation for the extension of the limits of the laboratory and the application of its methods to sociology as well as to the exact sciences and their allied practical branches. "Why not make organized society our laboratory!" says the professor of sociology. "See before us a fully working governmental machinery in the near-by city," says the professor of politics, "let us make it our laboratory." High schools, colleges and university schools are sending their students out into the busy world to observe, participate and learn by doing under competent direction. The medical school has, for years, had its post-graduate connection with the hospital which provides field work for the young interne; normal schools require their students to get experience as pupil teachers; coöperative courses in engineering (with part time in college and part time in real, commercial work) have been developed, and now departments of economics, sociology and government are devising ways of giving their students practical instruction through field work in official bureaus, social settlements and city departments.

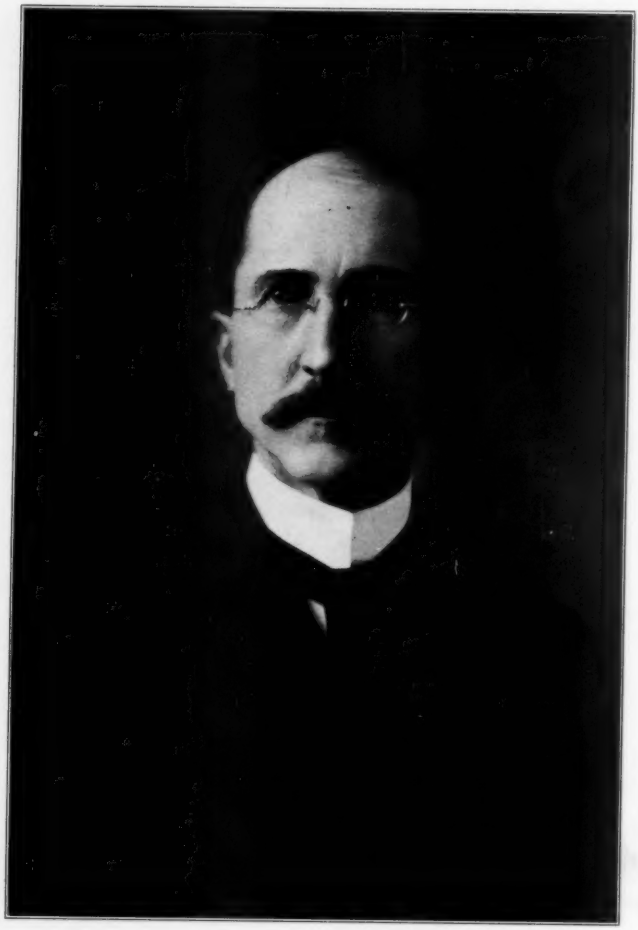
To study just how far it is desirable to extend teaching by field practice, the Association of Urban Universities has appointed a committee of nine prominent educators. This com-

mittee will make an extensive investigation and report on the value of field work; the wisdom of recognizing it with college credit, the methods of conducting it: the selection of students, organization of their work, correlation with formalized instruction, and the branches in which it may be used with advantage.

Some educational authorities who favor laboratory instruction within college walls do not consider it wise to devote part of a student's time to outside field work. They hold that the innovation is not a mere extension of the laboratory principle, but an entirely new principle. The advocates of field work are divided on the question of what constitutes field work, some holding that the field work of others is merely inspection and observation, not true work at all. No considerable group has agreed upon a standard definition or scale of credits toward graduation. The committee on field work will take up all these matters and render as complete a report as present practice and available information will make possible. The chairman of the committee is President Parke R. Kolbe of the Municipal University of Akron. The other members are: President Foster of Reed College, Dean Hatton of Western Reserve, President Dabney of the University of Cincinnati, President Godfrey of Drexel Institute, Dean Caldwell of the University of Chicago, Dean Lord of Boston University, Professor Dealey of Brown University and Professor Parsons of Syracuse. Members of this committee will welcome reports and other information from persons and institutions interested in the general problem of field work.

POSITION WANTED.

No. 930. Civil Engineer, university graduate, desires position as professor, associate professor or assistant professor of civil, highway, municipal, hydraulic or sanitary engineering or engineering mechanics. Nine years' teaching experience: surveying, mechanics, hydraulics, hydraulic laboratory, cement testing laboratory, graphics, concrete design, water supply, sewerage, railroads and highways. Four years' practical experience: topographic surveying, railroad location and construction, hydraulic engineering, municipal engineering and highway engineering.



HENRY S. JACOBY.

President Society for the Promotion of Engineering Education, 1915–16.
(See page 678.)